This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

IBRARY
L3 B

Digitized by Google

Sc, 1490.167

LIBRARY

OF THE

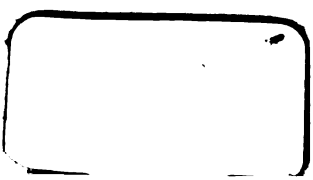
LAWRENCE SCIENTIFIC SCHOOL,

Engineering Department.

JUN 16 1904

SCIENCE CENTER LIBRARY

HARVARD COLLEGE
LIBRARY



Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Lawrence Scientific School
Engineering Library

SCIENCE ABSTRACTS.

Digitized by Google

Digitized by Google

SCIENCE ABSTRACTS.

SECTION B.—ELECTRICAL ENGINEERING.

VOL. VI.

1903.

Issued by the

INSTITUTION OF ELECTRICAL ENGINEERS,

92, VICTORIA STREET, LONDON, S.W.;

Compiled and Edited by the Institution, in association with

THE PHYSICAL SOCIETY OF LONDON;

With the Co-operation of

THE AMERICAN PHYSICAL SOCIETY,

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, and

THE AMERICAN ELECTRO-CHEMICAL SOCIETY.

LONDON:

E. & F. N. SPON, LIMITED, 125, STRAND, W.C.

NEW YORK:

SPON & CHAMBERLAIN, 123, LIBERTY STREET.

Digitized by Google

Sci 1490.167

Digitized by Google

ABSTRACTORS.

G. E. Allan, B.Sc.
A. H. Allen.
C. E. Allen.
R. Appleyard, A.M.Inst.C.E.
Ll. B. Atkinson.
G. H. Baillie.
W. C. Ball.
E. C. C. Baly, F.I.C.
E. H. Barton, D.Sc., F.R.S.E.
R. E. Baynes, M.A.
Fr. Beer, Ph.D.
H. Borns, Ph.D.
F. Broadbent, M.I.E.E.
S. H. Burbury, M.A., F.R.S.
C. P. Butler, A.R.C.Sc., F.R.P.S.
C. Capito, M.I.E.E.
J. D. Coales, B.Sc.
W. R. Cooper, B.Sc., A.I.C.
E. H. Cozens-Hardy.
W. J. Crawford.
E. G. Cruise.
H. R. Cullen, M.A.
A. Daniell, M.A.
C. R. D'Esterre.
W. P. Digby, A.M.I.M.E.
F. G. Donnan, M.A., Ph.D.
J. Erskine-Murray, D.Sc.
Miss A. Everett, M.A.
C. K. Falkenstein, Jr.
A. Fanti.
A. Findlay, M.A., Ph.D.
L. Gaster.
Prof. W. W. Haldane Gee, B.Sc.
G. Glaser, Ph.D.
A. Gradenwitz, Ph.D.
J. Gray, B.Sc.
Prof. A. Hay, D.Sc.
A. C. Heap.
J. B. Henderson, D.Sc.
W. C. Henderson, M.A., D.Sc.
H. M. Hobart.
H. F. Hunt, B.Sc.
D. H. Jackson, M.A., Ph.D.
Prof. A. Jamieson, M.I.C.E.
H. Lewis Jones, M.D.
J. B. C. Kershaw, F.I.C.
J. E. Kingsbury, M.I.E.E.
A. E. Levin.
T. M. Lowry, D.Sc.
W. G. McMillan, F.I.C.
M. O'Gorman, M.I.E.E.
J. W. Peck, M.A.
T. H. Pope.
T. S. Price, D.Sc., Ph.D.
W. G. Rhodes, D.Sc.
S. Rideal, D.Sc., F.I.C.
J. H. Rider.
E. C. Rimington.
R. C. Roberts.
L. S. Robertson, M.Inst.C.E.
Prof. W. Robinson, M.E.
E. S. A. Robson, M.Sc.
F. Rogers, B.Sc.
R. B. Rogers, M.A.
J. T. Rossiter, M.I.M.E.
F. J. Rowan, A.M.Inst.C.E.
A. Russell, M.A.
B. P. Scattergood, M.A.
E. K. Scott.
P. E. Shaw, B.A., D.Sc.
W. H. Simmons.
S. G. Starling, B.Sc., A.R.C.S.
O. J. Steinhart, Ph.D.
J. J. Stewart, M.A., B.Sc.
W. Stewart, M.A., D.Sc.
W. H. Story, M.A.
R. Threlfall, M.A., F.R.S.
W. E. Thrift, F.T.C.D.
G. W. de Tunzelmann, B.Sc.
J. L. F. Vogel.
E. J. Wade.
E. O. Walker, C.I.E., M.I.E.E.
L. H. Walter, M.A., A.M.I.C.E.
W. E. Warrilow.
R. S. Willows, B.A., D.Sc.
W. H. P. Young, B.A., M.D.

Digitized by Google

LIST OF JOURNALS.

In 1903 Abstracts were made from the following Journals. An asterisk (*) indicates that the Journals so marked were received only occasionally.

Abbreviation.	Full Title.	Price.	Publishers, or Agents.
Acad. Sci. Cracovie, Bull.	Bulletin de l'Académie des Sciences de Cracovie	Single copy, 90 centimes; 8 francs per annum	Librairie de la Société anonyme polonaise, Cracovie
Acad. Sci. St. Pétersbourg, Bull....	Bulletin dé l'Académie Impériale des Sciences de St. Pétersbourg	Single copy, 2 marks, 50 pfennigs	Published by the Academy
Acad. Sci. St. Pétersbourg, Mém.	Mémoires de l'Académie Impériale des Sciences de St. Pétersbourg	Single copy, 3 marks ...	Published by the Academy
Accad. Lincei, Atti	Atti della R. Accademia dei Lincei, Roma	——	Lungara 10, Roma, Italy
Accad. Sci. Torino, Atti.....	Atti della R. Accademia delle Scienze di Torino	——	Published by the Academy
Akad. Wiss. Wien, Sitz. Ber.	Sitzungsberichte der Mathematisch-Naturwissenschaftlichen Classe der Kaiserlichen Akademie der Wissenschaften, Wien	Single copies, 2s. 4d. to 7s. 6d.	Carl Gerold's Sohn, Barbaragasse 2, Vienna
Amer. Acad., Proc.....	Proceedings of the American Academy of Arts and Sciences	——	American Academy of Arts and Sciences, 1154, Boynton Street, Back Bay, Boston
Amer. Electn.	American Electrician	Single copy, 10 cents; $1 per annum	120, Liberty Street, New York
*Amer. Electrochem. Soc., Trans.	Transactions of the American Electrochemical Society	$3 per volume	2910, North Sixteenth Street, Philadelphia, Pa.
Amer. Inst. Elect. Engin., Trans.	Transactions of the American Institute of Electrical Engineers	Single copy, 50 cents; $5 per annum	Published by the Institute, 95, Liberty Street, New York
Amer. Journ. Sci. .....:...	American Journal of Science.....	$6.40 per ann., post free	Tuttle, Morehouse & Taylor, 125, Temple Street, New Haven, Connecticut, U.S.A.
Amer. Phys. Soc., Bull	Bulletin of the American Physical Society	——	——
Amer. Soc. Mech. Engin., Trans.	Transactions of the American Society of Mechanical Engineers	——	Published by the Society, 12, West Thirty-first Street, New York
Amer. St. Rly. Assoc.....	Report of the American Street Railway Association	——	2020 State Street, Chicago
American Telephone Journ.....	The American Telephone Journal	$1 per annum	116, Nassau Street, New York

These publications can be obtained from Messrs. WILLIAMS and NORGATE, 14, Henrietta Street, W.C.

Digitized by Google

Abbreviation.	Full Title.	Price.	Publishers, or Agents.
Ann. d. Physik	Annalen der Physik	38 marks per annum	J. A. Barth, Rossplatz 17, Leipzig
Annal. Chim. Phys.	Annales de Chimie et de Physique	36 francs per annum	Gauthier-Villars, Quai des Grands-Augustins 55, Paris
Annal. Scientifiques de l'Univ. de Jassy	Annales Scientifiques de l'Université de Jassy	10 francs per volume	—
*Annal. Soc. Sci. de Bruxelles	Annales de la Société Scientifiques de Bruxelles	20 francs per annum	6, Quai des Dominicains, Gand, Brussels
Archiv Post, Tele.	Archiv für Post und Telegraphie	—	Published by the Reichs-Postamt, Berlin
Archives d'El. Médicale	Archives d'Électricité Médicale	22 francs per annum	O. Doin, Place de l'Odéon 8, Paris
Archives Néerlandaises	Archives Néerlandaises des Sciences Exactes et Naturelles	6 fl. per volume	Martinus Nijhoff, La Haye, Holland
Archives des Sciences	Archives des Sciences Physiques et Naturelles, Genève	Single copy, 2.50 francs; 25 francs per annum	Bureau des Archives, 18 Pélisserie, Geneva
Assoc. Ing. El. Liége, Bull.	Bulletin de l'Association des Ingénieurs-Electriciens, Liége	20 francs per annum	Rue Sainte-Gilles, 31, Liége, Belgium
Astrophys. Journ.	Astrophysical Journal	Single copy, 50 cents; 18s. per annum	The University of Chicago Press, Chicago, and W. Wesley & Son, 28, Essex Street, Strand, W.C.
Atti dell' Assoc. Elettr. Ital.	Atti della Associazione Elettrotecnica Italiana	20 lire per annum	Sede Centrale, 397, Corso Umberto 1, Rome
Automobile Club Journ.	Automobile Club Journal	Single copy, 6d.	119, Piccadilly, London, W.
Automobile Rev.	The Automobile Review and Automobile News	Single copy, 10 cents; $1 per annum	Baltimore Building, 21, Quincy Street, Chicago
Automotor Journ.	Automotor and Horseless Vehicle Journal	Single copy, 6d.; 7s. per annum	F. King & Co., Ltd., 44, St. Martin's Lane, London, W.C.
British Optical Journal	The British Optical Journal	Single copy, 6d.; 5s. per annum	Harp Alley, Farringdon Street, London, E.C.
Bureau des Longitudes, Ann.	Annuaire publié par le Bureau des Longitudes	1 franc 50 centimes	Gauthier-Villars, Quai des Grands Augustins 55, Paris
Cambridge Phil. Soc., Proc.	Proceedings of the Cambridge Philosophical Society	Single copy, 2s. 6d.	C. J. Clay & Sons, Ave Maria Lane, E.C.
Cambridge Phil. Soc., Trans.	Transactions of the Cambridge Philosophical Society	Single copy, 7s. 6d.	C. J. Clay & Sons, Ave Maria Lane, E.C.
Canad. Elect. News	Canadian Electrical News	Single copy, 10 cents; $1 per annum	C. H. Mortimer Publishing Co., Ltd., Confederation Life Buildings, Toronto, Canada

These publications can be obtained from Messrs. Williams and Norgate, 14, Henrietta Street, W.C.

Digitized by Google

LIST OF JOURNALS—*continued.*

ABBREVIATION.	FULL TITLE.	PRICE.	PUBLISHERS, OR AGENTS.
Cassier	Cassier's Magazine	Single copy, 1s.; 12s. per annum, post free	33, Bedford Street, Strand, W.C.
Centralblatt Accumulatoren	Centralblatt für Accumulatoren- und Elementenkunde	3 marks 50 pf. per quarter	Dr. Franz Peters, Gross-Lichterfelde, West Bellevuestr. 40, Germany
Chem. & Metallurgical Soc., S. Africa	Journal of the Chemical, Metallurgical, and Mining Society of South Africa	Single copy, 2s.; 24s. per annum	Messrs. Simpkin, Marshall & Co., Paternoster Row, London, E.C.
Chem. News	Chemical News and Journal of Science	Single copy, 4½d. post free	E. J. Davey, 16, Newcastle Street, Farringdon Street, E.C.
Chem. Soc., Journ.	Journal of the Chemical Society	—	Gurney & Jackson, 1, Paternoster Row, E.C.
Chem. Soc., Proc.	Proceedings of the Chemical Society	—	Gurney & Jackson, 1, Paternoster Row, E.C.
Comptes Rendus	Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences	34 francs per annum	Gauthier-Villars, Quai des Grands Augustins 55, Paris
Deutsch. Phys. Gesell., Verh.	Verhandlungen der Deutschen Physikalischen Gesellschaft	4 marks per annum	Fr. Vieweg u. Sohn, Verlagsbuchhandlung, Braunschweig, Germany
Dioptric Review	The Dioptric and Ophthalmometric Review	7s. 6d. per annum	17, Shaftesbury Avenue, London, W.
Écl. Électr.	L'Éclairage Électrique	60 fr. per ann., post free	Ch. Cointe, 40, Rue des Écoles, Paris
Elect. Engin.	Electrical Engineer	Single copy, 3d.; 13s. per annum, post free	139 & 140, Salisbury Court, Fleet Street, E.C.
Elect. Rev.	Electrical Review (London)	Single copy, 4d.; 19s. 6d. per annum, post free	Alabaster, Gatehouse & Co., 4, Ludgate Hill, E.C.
Elect. Rev. N.Y.	Electrical Review (New York)	Single copy, 10 cents; $5 per annum	Times Buildings, 41, Park Row, New York, and H. W. Hall, 42, Old Broad Street, London, E.C.
Electrical Times	The Electrical Times and Lightning	Single copy, 2d.; 10s. 6d. per annum	8, Bream's Buildings, Chancery Lane, London, E.C.
Elect. World and Engineer	Electrical World and Engineer	Single copy, 10 cents; $6 per annum	120, Liberty Street, New York, & Hastings House, Norfolk Street, Strand, London
Electrician	The Electrician	Single copy, 6d.; 26s. per annum	Salisbury Court, Fleet Street, E.C.
Électricien	L'Électricien	Single copy, 50 centimes; 25 francs per annum	L. de Soye et Fils, Rue des Fossés-St.-Jacques 18, Paris
Electricity, N.Y.	Electricity (New York)	Single copy, 10 cents; $4.50 per annum	130, Liberty Street, New York

These publications can be obtained from Messrs. WILLIAMS and NORGATE, 14, Henrietta Street, W.C.

Digitized by Google

Abbreviation.	Full Title.	Price.	Publishers, or Agents.
Electrochem. Ind., N.Y.	Electrochemical Industry, New York	Single copy, 25 cents; $2 per annum	Electrochemical Publishing Company, 114–118, Liberty Street, New York City
Electro-Chemist	The Electro-Chemist and Metallurgist	Single copy, 6d.; 7s. 6d. per annum, post free	Sherard Cowper-Coles & Co., Ltd., 82, Victoria Street, Westminster
Elekt. Runds.	Elektrotechnische Rundschau	12 marks per annum	10, Kaiserstrasse, Frankfurt a. M., Germany
Elektrochem. Zeitschr.	Elektrochemische Zeitschrift	18 marks 40 pfg. per annum	M. Krayn, Kurfürstenstrasse, 11, Berlin, W. 57
Elektrotechn. Zeitschr.	Elektrotechnische Zeitschrift	25s. per annum	J. Springer, 24, Monbijouplatz, 3, Berlin, N.
Elettricista, Rome	L'Elettricista (Rome)	12s. per annum	Via Cavour 222–226, Rome
Elettricità, Milan	L'Elettricità	Single copy, 50 cents; 15 lire per annum	Via Boccaccio 5, Milan, Italy
Eng. and Mining Journ.	The Engineering and Mining Journal	$5 per annum	261, Broadway, New York
Engineer	The Engineer (London)	Single copy, 6½d. post free; £1 9s. per ann., post free	33, Norfolk Street, Strand, W.C.
Engineering	Engineering	Single copy, 6½d. post free; £1 9s. 2d. per annum, post free	35 & 36, Bedford Street, Strand, W.C.
Eng. Club, Phil., Proc.	Proceedings of the Engineers' Club of Philadelphia	$2 per volume	1122, Girard Street, Philadelphia
Eng. Mag.	The Engineering Magazine	Single copy, 1s.; 12s. 6d. per annum, post free	222–225, Strand, London, W.C.
Eng. News	Engineering News	Single copy, 15 cents; $6.31 per annum	220, Broadway, New York, and Effingham House, 1, Arundel Street, Strand, London
Eng. Record	The Engineering Record	Single copy, 12 cents; $6 per annum	100, William Street, New York
Feilden	Feilden's Magazine	Single copy, 1s.; 12s. 6d. per annum, post free	Temple Chambers, Embankment, London, E.C.
France Automobile	La France Automobile	Single copy, 50 cents; 20 francs per annum	68, Avenue de la Grande-Armée, Paris
Frank. Inst., Journ.	Journal of the Franklin Institute	Single copy, 50 cents; $5 per annum	Franklin Institute, Philadelphia
Génie Civil	Génie Civil	Single copy, 1 franc; 45 francs per annum	Rue de la Chaussée d'Antin 6, Paris
Gesell. Wiss. Göttingen, Nachr. Math.-Phys. Klasse	Nachrichten der Gesellschaft der Wissenschaften zu Göttingen, Mathematisch-physikalische Klasse	—	Lüder Horstmann, Göttingen, Germany

These publications can be obtained from Messrs. Williams and Norgate, 14, Henrietta Street, W.C.

Digitized by Google

LIST OF JOURNALS—*continued*.

ABBREVIATION.	FULL TITLE.	PRICE.	PUBLISHERS, OR AGENTS.
Horseless Age	The Horseless Age	Single copy, 10 cents; $4 per annum	E. P. Ingersoll, 150, Nassau St., New York
Ind. Élect.	L'Industrie Électrique	Single copy, 1 franc; 26 francs per annum	A. Lahure, 9, Rue de Fleurus, Paris
Ind. Électrochim.	L'Industrie Électrochimique	Single copy, 60 centimes; 8 francs per annum	H. Becker, 5, Rue Guy-Patin, Paris
Inst. Civ. Engin., Proc.	Proceedings of the Institution of Civil Engineers	—	Published by the Institution, Great George Street, London, S.W.
Inst. Elect. Engin., Journ.	Journal of the Institution of Electrical Engineers	Single copy varies from 1s. 6d. to 7s. 6d.	E. & F. N. Spon, 125, Strand, London, W.C.
Inst. Engin. and Shipbuilders, Trans.	Transactions of the Institution of Engineers and Shipbuilders in Scotland	—	Published by the Institution, 207, Bath Street, Glasgow
Inst. Mech. Engin., Proc.	Proceedings of the Institution of Mechanical Engineers	—	Published by the Institution, Storey's Gate, St. James's Park, London, S.W.
Inst. Naval Architects, Trans.	Transactions of the Institution of Naval Architects	—	H. Sotheran & Co., 140, Strand, London, W.C.
Iron and Steel Inst., Journ.	Journal of the Iron and Steel Institute ...	32s. per annum	E. & F. N. Spon, 125, Strand, London
Journal of Electricity, S. F.	Journal of Electricity, Power, and Gas (San Francisco)	Single copy varies from $25 to $50	144, Union Square Avenue, San Francisco
Journ. Phys. Chem.	Journal of Physical Chemistry	$4 per annum	Published at Cornell University, U.S.A.
Journ. de Physique	Journal de Physique	15 fr. per ann., post free	11, Rue Rataud, Paris
Journ. Télégraph.	Journal Télégraphique	Single copy, 50 centimes; 5 francs per annum	Bureau International des Administrations Télégraphiques, Berne
Jurn. Russk. Fisik.-Chimičesk. Obščestva	Jurnal Russkago Fisiko-Chimičeskago Obščestva	9 roubles per annum ...	Published by the Russian Physico-Chemical Society, Imperial University, St. Petersburg
Kongl. Danske Vidensk. Selsk. Kjöbenhavn, Förh.	Öfversigt over Det Kongelige Danske Videnskabernes Selskabs Förhandlinger	5 kr. per annum	Andr. F. Höst og Sön, Copenhagen
Koninк. Akad. Wetensch. Amsterdam, Versl.	Verslagen van de gewone vergaderingen der wis-en natur-Kundige afdeeling der Koninklijke Akademie van Wetenschappen te Amsterdam	—	Published by the Academy
Locomotion Automobile	La Locomotion Automobile	Single copy, 5 centimes; 20 francs per annum	Place de la Madeleine, Rue Chauveau-Lagarde 4, Paris

These publications can be obtained from Messrs. WILLIAMS and NORGATE, 14, Henrietta Street, W.C.

Digitized by Google

Abbreviation.	Full Title.	Price.	Publishers, or Agents.
London County Council, Report	London County Council Report	Single copy, 1s.	P. S. King & Son, 2 & 4, Great Smith Street, Victoria Street, Westminster, S.W.
Manchester Lit. and Phil. Soc., Mem.	Memoirs of the Manchester Literary and Philosophical Society	Single copy, 2s.	36, George Street, Manchester
Mathematical and Physical Soc. Tokyo	Tōkyō Sūgaku-Buturigakkwai, Hōkoku ...	——	——
Mech. Eng.	The Mechanical Engineer	Single copy, 6d.; 20s. per annum, post free	53, New Bailey Street, Manchester
Metallographist	The Metallographist	Single copy, 80 cents; $3 per annum.	Boston Testing Laboratories, 446, Tremont Street, Boston, U.S.A.
Monthly Weather Rev.	The Monthly Weather Review.....	Single copy, 10 cents ...	Published by the U.S. Weather Bureau, Washington
Motor Car Journ.	The Motor Car Journal	Single copy, 1d.; 6s. 6d. per annum	39 & 40, Shoe Lane, E.C.
Motorwagen	Der Motorwagen	16 marks per annum.....	M. Krayn, 86 Steglitzerstrasse, Berlin, W., 35
N. Cimento	Nuovo Cimento.....	20 lire per annum	A. Lavacchini, Via Sino Capponi 3, Florence
Nature	Nature.....	Single copy, 6d.	Macmillan & Co., Ltd., St. Martin's Street, London, W.C.
Nova Scotian Inst., Trans.	Transactions of the Nova Scotian Institute of Science	——	Published by the Institute, Halifax, Nova Scotia
Öfvers. Kongl. Vet. Akad. Stockholm, Förh.	Öfversigt af Kongliga Vetenskaps-Akademiens Förhandlingar, Stockholm	——	Published by the Academy
Page's Mag.....	Page's Magazine	12s. per annum	Clun House, Surrey Street, Strand, W.C.
Phil. Mag.	London, Edinburgh, & Dublin Philosophical Magazine	2s. 6d. per month, occasionally 5s.	Taylor & Francis, Red Lion Court, Fleet Street, E.C.
Photographic Journ.	The Photographic Journal	Single copy, 1s.	Messrs. Harrison & Sons, 59, Pall Mall, S.W.
Phys. Rev.	Physical Review	Single copy, 50 cents; $4 per annum	Macmillan & Co., Ltd., London and New York
Phys. Tech. Reichsanstalt, Wiss, Abh.	Wissenschaftliche Abhandlungen der Physikalisch-Technischen Reichsanstalt	30 marks per volume ...	J. Springer, Verlagsbuchhandlung, Monbijouplatz 3, Berlin, N.
Phys. Zeitschr.	Physikalische Zeitschrift	5 Mk. per quarter, or 25 Mk. per ann., post free	S. Hirzel, Königstrasse 2, Leipzig
Power, N.Y.	Power (New York)	$2 per annum	Hill Pub. Co., World Bldg., New York, and 6, Bouverie Street, Fleet Street, E.C.

These publications can be obtained from Messrs. Williams and Norgate, 14, Henrietta Street, W.C.

Digitized by Google

LIST OF JOURNALS—*continued.*

ABBREVIATION.	FULL TITLE.	PRICE.	PUBLISHERS, OR AGENTS.
Preuss. Akad. Wiss. Berlin, Sitz. Ber.	Sitzungsberichte der Preussischen Akademie der Wissenschaften zu Berlin	12 marks per annum	Königliche Akademie der Wissenschaften, Berlin
Railroad Gazette	Railroad Gazette	$6.08 per ann., post free	32, Park Place, New York
Revue de l'El., Berne	Revue de L'Electricité, Berne	8 francs per annum	Place de l'Ours 29, Berne
Revue Int. d'Électrothérapie	Revue Internationale d'Electrothérapie et de Radiothérapie	Single copy, 50 centimes; 6 francs per annum	3, Place du Théâtre Français, Paris
Revue Scientif.	Revue Scientifique	Single copy, 60 centimes; 35 francs per annum	41 bis, Rue de Châteaudun, Paris, and T. F. Unwin, 11, Paternoster Square, E.C.
Rivista Sci.-Industriale	Rivista Scientifico-Industriale	12 lire per annum	2, Lungarno della Zecca, Florence, Italy
Roentgen Ray, Archives	Archives of the Roentgen Ray	Single copy, 2s.	Reman, Ltd., 129, Shaftesbury Avenue, W.C.
*Royal Astron. Society, Monthly Notices	Monthly Notices of the Royal Astronomical Society	10s. per annum	Published by the Society, Burlington House, London, W.
Roy. Dublin Soc., Proc.	Scientific Proceedings of the Royal Dublin Society	Single copy, 6d.	Published by the Society, Leinster House, Dublin
Roy. Dublin Soc., Trans.	Transactions of the Royal Dublin Society	——	Published by the Society, Leinster House, Dublin
Roy. Inst., Proc.	Proceedings of the Royal Institution of Great Britain	——	Published by the Institution, 21, Albemarle Street, W.
Roy. Soc., Edinburgh, Proc.	Proceedings of the Royal Society of Edinburgh	Varies for separate papers	Messrs. R. Grant & Son, 107, Princes Street, Edinburgh, and Messrs. Williams & Norgate, 14, Henrietta Street, Covent Garden, London
Roy. Soc., Edinburgh, Trans.	Transactions of the Royal Society of Edinburgh	Varies for separate papers	Messrs. R. Grant & Son, 107, Princes Street, Edinburgh, and Messrs. Williams & Norgate, 14, Henrietta Street, Covent Garden, London
Roy. Soc. N. S. Wales, Journ. and Proc.	Journal and Proceedings of the Royal Society of New South Wales	——	5, Elizabeth Street, Sydney, New South Wales
Roy. Soc., Phil. Trans.	Philosophical Transactions of the Royal Society of London	Varies for separate papers, from 1s.	Dulau & Co., 37, Soho Square, London, W.
Roy. Soc., Proc.	Proceedings of the Royal Society of London	Varies for separate parts, from 1s. 6d.	Dulau & Co., 37, Soho Square, London, W.
*Roy. Soc., Queensland, Proc.	Proceedings of the Royal Society of Queensland	——	Pole & Co., 95, Elizabeth Street, Brisbane

These publications can be obtained from Messrs. WILLIAMS and NORGATE, 14, Henrietta Street, W.C.

Digitized by Google

Abbreviation.	Full Title.	Price.	Publishers, or Agents.
Roy. Soc. Victoria, Proc.	Proceedings of the Royal Society of Victoria	——	Published by the Society, Melbourne London Agents: Williams & Norgate, 14, Henrietta Street, Covent Garden, W.C.
Russian Physical and Chemical Soc. Journ.	Journal de la Société Physico-Chimique-Russe à l'Université de St. Pétersbourg	——	Published by the Society, St. Petersburg
Schweizerische Blätter für Elektrotechnik	Schweizerische Blätter für Elektrotechnik, Berne	8 francs per annum	Place de l'Ours 29, Berne
Science	Science	Single copy, 15 cents	Macmillan & Co.,66, Fifth Avenue,New York
Scientific American	Scientific American	Single copy, 8 cents; 16s. 5d. per annum, post free	361, Broadway, New York
Scientific Australian	Scientific Australian	2s. 6d. per annum, post free	Turner & Henderson, 16–18, Hunter Street, Adelaide
Soc. Arts, Journ.	Journal of the Society of Arts	Single copy, 6d.	G. Bell & Sons, York Street, Covent Garden, W.C.
Soc. Belge Élect., Bull.	Bulletin de la Société Belge d'Électriciens	Single copy, 2 francs; 20 frs. per ann., post free	54, Rue Froissart, Brussels
Soc. Chem. Ind., Journ.	Journal of the Society of Chemical Industry	30s. per annum	Published by the Society, 9, Bridge Street, Westminster, S.W.
Soc. Franç. Phys., Bull	Bulletin de la Société Française de Physique	——	Published by the Society, 44, Rue de Rennes, Paris
Soc. Franç. Phys., Séances	Séances de la Société Française de Physique	——	Published by the Society, 44, Rue de Rennes, Paris
Soc. Imp. Nat. Moscou, Bull.	Bulletin de la Société Impériale des Naturalistes de Moscou	——	J. N. Kouchnereff & Co., Pimenowskaia, Moscou
Soc. Int. Élect., Bull.	Bulletin de la Société Internationale des Electriciens	Single copy, 2.50 francs; 27 francs per annum	Gauthier-Villars, Quai des Grands-Augustins 55, Paris
Street Rly. Journ.	Street Railway Journal	Single copy, 50 cents; $6 per annum, post free	A. C. Shaw, Hastings House, Norfolk Street, Strand, W.C.
Street Rly. Rev.	Street Railway Review	Single copy, 30 cents; $4 per annum	Windsor and Kenfield Pub. Co., Monon Bldg., Chicago, and 82, Fleet Street, E.C.
Technology Quarterly	The Technology Quarterly and Proceedings of the Society of Arts (Boston)	$3 per annum	Published by the Society of Arts of the Massachusetts Institute of Technology, Boston, Mass.
Tech. Versuch., Berlin, Mitth.	Mitteilungen aus den Königlichen Technischen Versuchsanstalten zu Berlin	12 marks per annum	J. Springer, Verlagsbuchhandlung, Monbijouplatz, 3, Berlin, N.

These publications can be obtained from Messrs. Williams and Norgate, 14, Henrietta Street, W.C.

Digitized by Google

LIST OF JOURNALS—*continued.*

ABBREVIATION.	FULL TITLE.	PRICE.	PUBLISHERS, OR AGENTS.
Terrestrial Magnetism	Terrestrial Magnetism and Atmospheric Electricity	Single copy, 75 cents; $2.75 per annum	Johns Hopkins Press, Baltimore, U.S.A.
Tram. Rly. World	Tramway and Railway World	Single copy, 1s. post free	Amberley House, Norfolk Street, W.C.
U.S. Weather Bureau, Bull.....	Bulletin of the United States Weather Bureau	——	Published by the U.S. Weather Bureau, Washington
*Vid.-Selsk. Forh., Christiania ...	Christiania Videnskabs, Selskabs, Förhandlingar	——	J. Dybwad, Christiania
West. Electn.	Western Electrican (Chicago)	Single copy, 10 cents; $3 per annum	510, Marquette Buildings, Chicago, and 44, Fleet Street, London, E.C.
Western Soc. Engin., Journ.	Journal of the Western Society of Engineers	$2 per volume of six numbers	Published by the Society, 1734–41, Monadnock Block, Chicago
Zeitschr. Anorg. Chem.	Zeitschrift für Anorganische Chemie	Single copy, 3 marks.....	Leopold Vors, Leipzig
Zeitschr. Elektrochem.	Zeitschrift für Elektrochemie	4 marks per quarter	W. Knapp, Halle a. S., Germany
Zeitschr. Elektrotechn., Wien.....	Zeitschrift für Elektrotechnik (Wien)	30 fr. per ann., post free	Nibelungengasse 7, Vienna
Zeitschr. Instrumentenk.	Zeitschrift für Instrumentenkunde	20 marks per annum.....	J. Springer, 24, Monbijouplatz 3, Berlin
Zeitschr. Instrumentenk., Beib. ...	Beiblatt zur Zeitschrift für Instrumentenkunde		
Zeitschr. Phys. Chem.	Zeitschrift für Physikalische Chemie	Single copy about 4s. 3d.	W. Engelmann, Leipzig
Zeitschr. Vereines Deutsch. Ing.	Zeitschrift des Vereines Deutscher Ingenieure	Single copy, 1 mark 40 pfg.; 32 marks per annum, post free	J. Springer, Monbijouplatz 3, Berlin

These publications can be obtained from Messrs. WILLIAMS and NORGATE, 14, Henrietta Street, W.C.

Digitized by Google

ERRATA.

Section B.—ELECTRICAL ENGINEERING.

Abstract No. 51 : *for* June, *read* April.

No. 95, line 5 : *for* No. 2030 (1902), *read* No. 2030 (1901).

No. 122 : *for* June, *read* April.

No. 124 : *for* June, *read* April.

No. 130, line 9 : *for* 200,000 francs, *read* 2,000 francs.

No. 164, line 2 : *for* Électricien, 23, *read* Électricien, 24.

No. 164, line 27 : *for* thickness of 10 mm., *read* thickness of $\frac{1}{10}$ mm.

No. 169, line 3 : *for* and pipes, *read* in pipes.

No. 214, line 2 : *for* Abstracts Nos. 1440 (1901) and 1351 (1902), *read* Electrician, 37. pp. 766–770, 1896.

No. 240 : *for* June, *read* April.

No. 252, p. 99, line 2 : *for* $\left(V = \frac{V}{100\,C + V}\right)$, *read* $V' = \frac{100\,V}{C + V}$.

No. 371, line 7 from end : *for* (£32), *read* (£16).

No. 394, line 14 from end : *for* Bedson said, &c., *read* Bedson said that creosote at $\frac{1}{2}$d. per gallon was equivalent (in cost) to slack at 4s. 6d. per ton (1 ton slack = over 100 gallons of oil).

No. 397, line 6 : *for* 250 kw., *read* 280 kw.

No. 1003, line 9 : *for* bus-bars, and main transformers should have, *read* bus-bars and the main transformers and have.

Digitized by Google

Digitized by Google

SCIENCE ABSTRACTS.

Section B.—ENGINEERING.

JANUARY 1903.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

1. *Corliss Engines.* (Engineering, 74. pp. 36, 37, and 46, July 11, 1902.)—This is a description of 700-h.p. engines, for driving traction dynamos, built by Cole, Marchant & Morley, of Bradford, for the tramway station at Auckland, New Zealand. The valve gear is of the modified Corliss type, to suit the speed of 100 r.p.m.; the guarantee provides that the permanent variation of speed shall not exceed 2½ per cent. between no load and 25 per cent. overload. The governor is of the Hartnell type, and is driven by a Renold chain; there is also a safety stop actuated by an electrical relay.

H. R. C.

2. *Torsional Stress in the Connection between a Ship's Engines and the Propeller.* **H. Frahm.** (Phys. Zeitschr. 3. pp. 481–488, July 15, 1902. Paper read before the 73rd Naturforscherversammlung at Hamburg.)—The experiments described were carried out on vessels constructed by Messrs. Blohm and Voss. In large steamships the distance from the engines to the propeller is so considerable that the connecting pieces cannot be regarded as rigid, but must be looked upon as more or less elastic springs kept in torsion by the turning movement communicated to the propeller by the engines. If the engines revolved uniformly, the torsion in the connection would be constant, but variation in the speed of the ordinary engine causes variation in the torsion and in the speed of the connecting pieces and propeller. Two very thin pieces of zinc leaf, coated with a prepared conducting oxide, are fastened round the connecting piece as far as possible apart; against each of those presses a platinum point; when an electric current flows (but not unless) the points record a mark on the prepared surface. The position of the points is marked exactly when the connector is free from torsion. After the engines have run steadily for a time the platinum points are caused by a suitable arrangement to move forward parallel to the axis of the connector, the current being allowed to pass, so that marks are recorded on the prepared surface. On the interruption of the current the record ceases. Since both marks are made in the same time, the velocity curves can be got by placing the zinc leaves in different positions on the connector. The displacement

Digitized by Google

of a point on the connector can be got similarly by placing the zinc leaves close together so that when the connector is free from torsion the marks are exactly above each other; from this the torsional stress can be calculated; also from the curve so drawn the mean turning moment transmitted to the propeller can be easily calculated, and the b.h.p. found; the modulus of elasticity was found by separate experiment on specimen connectors. The results show that the connector vibrates much more than would be expected from the variations in the speed of the engines, the stress during a revolution sometimes rising to three times the mean value and going back through zero to the same amount in the opposite direction; hence a probable cause of fracture of propeller shafts. W. S.

3. *Horizontal Return Tubular Boiler for 400 h.p.* (Power, N.Y. 22. pp. 14–16. July, 1902.)—This boiler is remarkable on account of its dimensions, the shell being 90 in. in diameter, 20 ft. 8¾ in. long, and formed of ½-in. plates. There are 258 return tubes of 3 in. diameter, each 20 ft. long, placed at a distance of 3¾ in. centres apart. The constructional details are well-illustrated in the article, but are not unusual. Evaporative tests with both hand and machine stoking gave good results, the efficiency of the boiler based upon dry coal having been 73·14 and 73·43 per cent. with hand firing, and 76·14 and 70·56 per cent. with machine stoking. F. J. R.

4. *Report of the Committee on Naval Boilers.* (Engineering, 74. pp. 54–56, July 11, and pp. 90–94, July 18, 1902.)—This is the final Report of the Admiralty Committee on Boilers, and as the previous Interim Reports foreshadowed [see Abstracts Nos. 2284 (1901) and 1174 (1902)] the conclusions arrived at are in favour of the retention of water-tube boilers in vessels of H.M. Navy, but adverse to the further employment of the Belleville type of boiler, the disadvantages of which are set forth at length. The requisite features of a good water-tube boiler as compared with the cylindrical boiler are stated, but though possessing some of these, it is held that the disadvantages of the Belleville boiler more than counterbalance them in its case. The defects which have arisen in the ordinary working of Belleville boilers, some of which are said to be inherent to the system, are stated, and then the Report deals with the general suitability of the propelling and auxiliary machinery fitted in recent warships, as to which the Committee make some suggestions with a view to improvement. With regard to other designs of water-tube boilers, the Committee recommend further trial of Babcock-Wilcox, Niclausse, Dürr and Yarrow large tube boilers, examples of which they have watched in several vessels in and outside of the Navy; but without the experience of continued duty over a long period the Committee cannot recommend any existing boiler as a standard type for use in the Navy. Altogether they have had thirty-six different designs of water-tube boilers under consideration, the names of which are given. In addition to the four already named for further trial, they suggest that the progress of the Weir, Stirling, Thornycroft-Marshall and Thornycroft-Schulz designs should be watched with a view to determining if they are suitable for large vessels. Their general conclusion is that no type of water-tube boiler at present in use is on general service as economical as the cylindrical boiler. Until, therefore, a thoroughly satisfactory type of water-tube boiler is obtained, the Committee recommend that large cruisers and battleships should be fitted with cylindrical boilers sufficient to work the auxiliary machinery and drive the ship at ordinary cruising speed, and with water-tube boilers for driving the ship at high speeds, the steam

Digitized by Google

pressure being made 210 lbs. for all boilers. The Report is signed by all the members of the Committee except Mr. J. List, who adds a long document detailing the points as to which his general agreement with the Report is modified. These embrace some considerations as to defects which appeared in the boilers of the *Hyacinth, Minerva,* and *Europa;* Condensers; Jackets; Pumps; Propelling Machinery; White Metal; Nickel Steel; Grease Filters; Evaporators and Distillers; Electrically driven Auxiliaries; Forced Draught, and other matters. F. J. R.

5. *Stirling Marine Boiler.* (Engineer, 94. pp. 127–128, Aug. 8, 1902.)—The article illustrates the form of this boiler adopted for marine work in some experiments in the steam yacht *St. Clement,* with engines indicating 200 h.p. A tabular statement of the results of two trials, when burning 16 lbs. and 30 lbs. coal per square foot of grate area, is given as supplied by the Stirling Boiler Co. This shows an evaporation of 10·3 and 8·92 lbs. of water per lb. of coal with feed at 102° and 100° F., the evaporation per square foot of heating surface per hour being 4 lbs. and 6·26 lbs., reckoned from and at 212° F. The temperature at funnel is said to have been 470° and 580° F. when burning unriddled Welsh coal. F. J. R.

6. *Causes of Explosion of Steam Boilers, and means of Prevention.* **J. Fournier.** (Comptes Rendus, 135. pp. 282–285, July 28, 1902.)—Explosions caused by deposits of lime from calcareous waters are often due to inefficiency of safety valves. The ordinary lifting safety valve with direct spring should give an opening large enough to guard against accident when the valve is raised to a quarter of the diameter of the escape opening, but the pressure required to raise the valve increases with every fraction from the beginning in proportion as it is raised and the spring is compressed. The author proposes a valve with inverted seat, operated by a manometric tube alongside which is open at one end to the boiler, and at the other actuates one end of a rocking lever, which when moved depresses and so opens the valve. This arrangement, he maintains, prevents the abnormal additions to the pressure necessary to fully open the valve which exist in the ordinary design. F. J. R.

7. *Tests of Steam-pipe Coverings.* **G. H. Barrus.** (Amer. Soc. Mech. Engin., Trans. 23. No. 952. pp. 791–837; Discussion, pp. 837–845, 1902.)—This is an extended paper on a subject already treated shortly by the same author [see Abstract No. 947 (1902)]. It contains illustrations of the apparatus employed, diagrams and tables of the results. In his conclusions the author points out the fact that the most efficient covering was the one most closely resembling hair felt in its texture. In air-cell coverings those are most efficient in which the corrugations forming the air cells extend circumferentially round the pipe, as compared with cells extending lengthwise. As regards the relative efficiencies of high- and low-pressure coverings, the high-pressure coverings give the best results, even with low-pressure steam; and although they are 70 per cent. dearer in first cost, they are cheaper when tested over a period. The average cost of the high-pressure coverings at the end of five years' service with 80 lbs. steam pressure (taken on the basis of cost given in Table 8 accompanying the paper) is $14,693, whilst the low-pressure coverings in same time cost $18,525. The relative efficiencies are expressed in cost of coal required to supply the heat lost by radiation. In the *Discussion* **W. Kent** stated that the cost of allowing pipes to go uncovered with steam of 80 lbs. pressure was, according to the author's

Digitized by Google

results, $1·27 per square foot of pipe per annum, and with steam of 150 lbs., $1·61, and that these latter figures would be reduced to 80 cents by using the worst of the coverings tested, and to 22 cents by the best. F. J. R.

8. *Coal Storage Plant.* **F. M. Bowman.** (Amer. Soc. Mech. Engin., Trans. 23. No. 935. pp. 478–482, 1902.)—This paper contains a description, with photographs and plans of the building and conveyors for storing about 25,000 tons of coal for the Gas Light Company, at Lowell, Mass. It is a steel frame structure with concrete walls, foundations, and floor, the roof being covered with tiles. A conveyor tunnel runs through the length of the building under the centre of the floor, which is inclined from the side walls to the centre to facilitate removal of the coal. An overhead conveyor is carried by a channel tie across the centre of the roof truss near the ridge. The form of the girders constituting the roof permits of this arrangement; the bracing is done by means of inclined back legs placed outside the columns, and the columns are placed vertically and encased in concrete to protect them from corrosion by contact with the coal. Special tubes for testing the temperature of the coal at intervals along the building, and means for quickly emptying any portion or "pocket" of the store are provided. F. J. R.

9. *Liquid Fuel Combustion.* **C. E. Lucke.** (Amer. Soc. Mech. Engin., Trans. 23. No. 936. pp. 483–508; Discussion, pp. 508–510, 1902.)—The author recounts a long series of experiments with variously arranged burners for liquid fuel, in which he aimed at producing combustion in a closed chamber so that heated gases might be delivered with regularity to a hot-air engine. The general tendency of his results was to direct him away from special vaporisers and towards automatic regulation, with vaporisation taking place in the firebox in presence of air, the simplest arrangements being the best. He finally evolved an apparatus feeding oil or gas and air simultaneously in explosive proportions into a mass of broken rock, which became intensely hot underneath the surface and throughout the mass. Excess of oil or of gas could be burned on the surface without interfering with the "explosive combustion" taking place in the mass. There are many diagrams of experiments in the paper, and photographs of the completed apparatus at the end.
F. J. R.

GAS AND OIL ENGINES.

10. *Comparison of Gas Engines of Different Powers.* **M. Ringelmann.** (Comptes Rendus, 134. pp. 1293–1295, June 2, 1902.)—The hourly consumption of fuel by gas-motors may be taken as represented by the binomial $a + bx$, where a and b are constants depending respectively on the construction of the motor and on the character of the fuel, and x denotes the hourly work done. The specific consumption is then $y = (a + bx)/x$; and the relative merits of different motors, whatever their powers, may be judged, as at a recent competition in Paris [see Abstract No. 880 (1902)], by drawing their consumption-curves from their performances at half and full speed, and noting the relative positions of these hyperbolæ. R. E. B.

11. *Chemical Behaviour of Alcohol in the Alcohol Motor.* **A. Neuburger.** (Motorwagen, 5. pp. 205–206, July 15, and pp. 221–222, July 31, 1902.)—When alcohol is exploded with air in the cylinder of a motor it gives rise to small proportions of acetic acid which attack the walls of the cylinder and the

Digitized by Google

valve and cause them to rust. This difficulty may be readily overcome by mixing with the alcohol a small proportion of either benzene or of the cheaper benzine obtained from the distillation of petroleum. T. H. P.

12. *Lister Two-Stroke Engine.* (Automotor Journal, 7. pp. 462–463, Aug. 23, 1902.)—In this engine there are two parallel vertical cylinders mounted on an air-tight crank chamber. The combustion chambers are permanently interconnected and the pistons are coupled to the extremities of a triangular lever, pivoted at its apex on the crank-shaft. The triangular lever is constrained to oscillate about a fixed point on the crank chambers by a lever pivoted at a point on its base and on the crank chamber. Near the bottom of its stroke one of the pistons uncovers an exhaust port while a little earlier the other piston opens the air inlet port from the crank chamber, there being a non-return valve in this port. The hydrocarbon is introduced into the cylinders by means of a force pump. The charge having been introduced into the cylinders it is compressed equally in both, exploded, and expanded on the descent of the pistons. Near the bottom of the crank throw the air inlet port is uncovered in one cylinder and a little later the exhaust port is opened, the incoming air in the one cylinder aiding the exhausting of both. On their return stroke both pistons are compressing a fresh charge. C. R. D'E.

13. *Duvinage Carburettor.* **A. Mulhoux.** (Locomotion Automobile, 9. pp. 517–519, Aug. 14, 1902.)—This is a spray carburetter for internal combustion engines in which the velocity and quantity of air passing the jet and that added to the mixture after its formation, are regulated mechanically according to the speed of the engine. Rotating diaphragms in the air admission passages are employed to regulate the quality of the mixture.
C. R. D'E.

14. *Calvert Carburettor.* (Locomotion Automobile, 9. pp. 533–534, Aug. 21, 1902.)—This carburettor consists of a cylindrical chamber in which is a light valve controlled by a spring and normally closing the air inlet passages, the lower extremity of the valve spindle stands slightly above a spring controlled ball valve which closes the petrol supply pipe. When the engine is started the suction draws down the air valve and the stem striking the bell opens the petrol supply; the lift of the air valve is regulated by an external adjustment.
C. R. D'E.

AUTOMOBILISM.[1]

15. *Prescott Steam Car.* (Automotor Journal, 7. pp. 459–460, Aug. 23, 1902.)—This is a light American steam car modelled closely on the well-known lines of the Locomobile Car [see Abstract No. 547 (1902)]. The boiler is of the vertical fire-tube type, and the engine is a two-cylinder coupled vertical, with crank-shaft geared to the live rear axle by a single chain. C. R. D'E.

16. *Weston Steam Cars.* (Automotor Journal, 7. pp. 411–412, Aug. 9, 1902.)—These light American steam cars are modelled closely on the well-known "Locomobile" lines. The boiler is of the vertical fire-tube type, and petrol or gasolene fuel is used for firing. The engine is a two-cylinder vertical mounted in front of the boiler. The transmission gear consists of a

[1] Electric Automobiles are described in the Section dealing with Electric Traction.

Digitized by Google

single chain between crank-shaft and live rear axle. The engine and boiler are placed beneath the carriage body and attached thereto, the whole being sprung from a steel tube underframe. C. R. D'E.

17. *Steam Motor Lorry.* (Engineer, 94. pp. 129–131, Aug. 8, 1902.)—A new arrangement of mechanism for a steam lorry designed by A. W. Brightmore, and manufactured by Messrs. Coulthard, of Preston, is described. The distinctive feature consists in the arrangement of the whole of the propelling mechanism on an independent fore carriage pivoted on the lorry platform, and suitably attached thereto to enable it to draw the load. This fore carriage is entirely below the platform level with the exception of the boiler chimney. The boiler is of the vertical fire-tube type and is fired with coke. The engine is a horizontal compound. The power is transmitted by spur gearing to a horizontal differential gear shaft, from the ends of which the road wheels are driven by Renold's silent chains. Two speeds, about 8 and 6 miles per hour, are provided by two changes of spur gearing. C. R. D'E.

18. *Novel Steam Lorry.* (Automotor Journal, 7. pp. 477–481, Aug. 30, 1902.) —This is an American steam lorry in which the front wheels are drivers and rear wheels steerers. A horizontal fire-tube boiler, mounted toward the front of the vehicle, supplies steam to two independent engines geared direct to the front wheels. These engines are of peculiar construction, having each four single-acting cylinders, which are caused to operate a bevel wheel so mounted that the downward pressure of the pistons imparts to it a gyratory motion. The teeth of this bevel wheel mesh with those of a fixed vertical bevel ring upon which it rolls, while a second bevel, which moves with it, gears with a bevel pinion on the road-wheel axle. In this manner one engine and reduction gear is combined with each driving wheel of the lorry. The two engines form a compound set with four high- and four low-pressure cylinders. C. R. D'E.

19. *Henriod Cars.* (France Automobile, 7. pp. 555–557, Aug. 30, 1902.)— The latest types of Henriod petrol cars are here described. The under-frame is constructed of steel tubes, and spring on semi-elliptic plate springs from front and rear axles. The motor, which has one, two, or four vertical cylinders according to its power, is mounted towards the front of the frame and enclosed by a bonnet. The power is transmitted through a cone friction clutch to the change-speed gear, and by a jointed tail-shaft to the bevel reduction gearing on the live rear axle. The engine cylinders and heads are cast together and water-cooled throughout. The carburettor is of the spray-ing type with petrol supply regulated by a valve lifted by the air suction. [See also Abstract No. 2477 (1900).] C. R. D'E.

20. *Klingenberg Car.* (Motorwagen, 5. pp. 206–208, July 15, 1902.)—This is an illustrated article descriptive of the light petrol car manufactured by the Berlin Automobile Company. The characteristic feature of this car is the arrangement of the motor at the rear of the car with its crank-shaft forming part of the back axle, and transmitting power to the axle through counter-shafts and interposed spur wheels. The transmission gearing, which is wholly enclosed in a casing surrounding the axle, is distributed on opposite sides of the motor flywheels which are situated midway between the wheels of the vehicle. J. G.

Digitized by Google

21. *Recent German Lorries.* (Automotor Journal, 7. pp. 417–420, Aug. 9, 1902).—Four types of lorries driven by internal combustion engines are described. The Berliner Motorwagenfabrik Templehof lorry, built to carry a load of 2,500 kg. and having a tare weight of 2,200 kg., is propelled by a double-cylinder vertical engine mounted towards the front of the underframe, the power being transmitted to the rear road wheels through a spur wheel change-speed gear and bevel gearing on the live axle. The engine cylinders are 120 mm. bore × 140 mm. stroke, and 10 b.h.p. is developed at about 900 r.p.m. The engine is started on petrol and is then run on alcohol. The same firm makes a light delivery van for loads up to 1,000 kg., and with tare weight 800 kg., propelled by a single-cylinder engine and with belt and spur-wheel transmission gearing to the live rear axle. The lorries of Rudolph Hajen, of Cologne, built for loads up to 2·5 tons, are propelled by a single-cylinder engine running at a normal speed of 450 r.p.m. The power is delivered from the half-speed shaft of the engine and transmitted to the live rear axle by means of a special link and clutch mechanism in which speed variation is obtained by altering the throw of the links. The "Wardburg" lorries, for loads up to 2,000 kg., are very similar to those of the Berliner Motorwagenfabrik, being propelled by double-cylinder vertical engines, which run either on petrol or alcohol fuel. C. R. D'E.

22. *de Dietrich Car.* (France Automobile, 7. pp. 457–459, July 19, 1902.)—This vehicle is a radical departure from the well-known types manufactured by the de Dietrich Company. It has a rectangular underframe of wood reinforced with steel plates and supported from the axles on semi-elliptic springs. The engine is of the four-cylinder vertical type, mounted towards the front of the underframe, and is rated at from 16 to 20 b.h.p. The transmission is by cone clutch and spur wheel change-speed gear from crank-shaft to a longitudinal counter-shaft, and thence by bevel gearing to a cross-shaft carrying the differential gearing. The final transmission is by roller chains to the rear road wheels. Several good illustrations of the mechanism are given. C. R. D'E.

23. *"Long-distance" Touring Carriage.* (Horseless Age, 10. pp. 9–10, July 2, 1902.)—Describes a new petrol car manufactured by the Long Distance Automobile Company. It is propelled by a single-cylinder horizontal engine developing 7 h.p. at 700 r.p.m. mounted towards the front of the underframe. A three-speed forward and one reverse-speed change gear on the epicyclic system is employed, and the final transmission to the live rear axle is by a roller chain. The engine cylinder is 5-in. bore by 7-in. stroke. The general arrangement of the valve mechanism is similar to that of a gas engine, the cam shaft being longitudinal and driven by helical gearing. The ignition is low-tension electric. The make and break operating mechanism being mounted on a spindle driven by helical gearing from the half-speed shaft, the pinion of this gearing is of wide face so that the spindle may be moved longitudinally and hence partially rotated without disengaging the gearing. In this manner the point of firing may be advanced or retarded. A flywheel governor controls the engine by actuating the ignition spindle. C. R. D'E.

24. *Chatel-Jeannin Petrol Car.* (Automotor Journal, 7. pp. 440–444, Aug. 16, 1902.)—In this car the distinctive feature consists in the combination of engine, transmission gear, and live axle within a single gear-case between

Digitized by Google

the driving road wheels. The engine is of the horizontal single-cylinder type with crank disc flywheels. The connecting rod is coupled to the two halves of the crank-shaft by internal toothed gearing so arranged that they may move relatively to one another and supply the necessary differential for the live axle. The two halves of the axle are driven either direct by internal spur gears from the ends of the engine shaft or through a sun and planet motion which gives a slow forward and a reverse speed. C. R. D'E.

25. *Friedman Light Car.* (Automotor Journal, 7. pp. 484–486, Aug. 30, 1902.)—This is a light two-seated vehicle propelled by a double-cylinder horizontal internal-combustion engine. The chief feature of design lies in the transmission mechanism, in which changes of the speed of the vehicle are obtained by varying the point of contact of two friction discs mounted on shafts at right angles to one another. C. R. D'E.

26. *Ivel Agricultural Motor.* (Automotor Journal, 7. p. 361, July 26, 1902.)—This vehicle is constructed to serve either as a tractor for drawing mowers or reapers or as a portable motor for driving chaffcutters, &c. It consists of a channel steel underframe mounted on three wheels, a single steerer in front and two drivers on a live rear axle. The mechanism is mounted direct on the underframe and comprises a double-cylinder horizontal petrol motor of 8 h.p. with a surface type carburrettor and electric ignition, and transmission gearing by cone clutch and Renold's silent chain to a counter-shaft lying across the frame, and thence by roller chain or crossed belt to the differential gear on the live rear axle, the belt drive being only used for backward travelling. At the opposite end of the counter-shaft from that carrying the belt and chain drive are mounted fast and loose pulleys to be used for the driving of any stationary machinery. C. R. D'E.

27. *Franklin Light Roadster.* (Horseless Age, 10. pp. 104–105, July 23, 1902.)—This is a light petrol car fitted with a four-cylinder air-cooled engine, mounted towards the front of the underframe, and with crank axis lying transversely to the frame. The change-speed gear is of the epicyclic type, and gives two speeds forward and one reverse. The final transmission to the live rear axle is effected by means of a long roller chain. The engine cylinders are 3·25 bore by 3·25 stroke, and it developes 7 b.h.p. at 1,200 r.p.m. The vehicle seats two persons, and its total weight is about 1,000 lbs.
C. R. D'E.

28. *Columbia Petrol Voiturette.* **D. Bellet.** (Locomotion Automobile, 9. pp. 516–517, Aug. 14, 1902.)—This is a light car propelled by a single-cylinder vertical engine of 114 mm. bore by 172 mm. stroke, with water-cooled head and air-cooled body, stated to develope 4·5 h.p. at 500 to 600 r.p.m. The underframe is constructed of steel tube ; the longitudinal frame members are directly connected to the front and rear axles, elliptic plate springs being provided to carry the weight of carriage body and passengers only. The power is transmitted from engine to change-speed gear through a friction clutch and the final transmission to the live rear axle is by bevel gearing. The total weight of the vehicle ready for the road is 720 kg. C. R. D'E.

29. *Humber Motor Bicycle.* (Automotor Journal, 7. pp. 389–390, Aug. 2, 1902.)—In this machine the engine, which is of the single-cylinder, air-cooled type, is mounted between the arms of the stay connecting the bottom bracket

Digitized by Google

and head. The petrol tank and carburettor are mounted in the frame below the top stay. The transmission from the engine to rear wheel is by a double chain and clutch gear giving a reduction of 6 to 1. The engine cylinder is $2\frac{3}{8}$ in. bore by 3 in. stroke, and it developes 2 b.h.p. at 1,800 r.p.m. The carburettor is of the surface type. The ignition is electric, a coil with magnetically operated trembler being employed. C. R. D'E.

30. *Mathieu Steering Gear.* (France Automobile, 7. p. 491, Aug. 2, 1902.)—In this steering mechanism the gearing between hand wheel and road wheels is of the screw and nut type, the special feature being that in addition to the ordinary screw and nut in direct connection with the levers of the steering mechanism there is an additional threaded portion on the steering rod working in a nut at the upper extremity of the fixed steering pillar. The threads at the top and bottom of the steering rod are right hand and left hand respectively. C. R. D'E.

31. *Graphite Lubrication for Automobiles.* **H. D. Meier.** (Horseless Age, 9. pp. 712–714, June 11, 1902.)—The author advocates the use of graphite for lubricating both the cylinders and bearings of automobiles. To obtain a regular feed, it should be mixed with oil in the proportion of 5 per cent. of graphite to 95 per cent. of oil. The vibration of the machine will prevent the graphite from settling. A mixture of grease with graphite may also be employed. The appended table is given containing the results of tests made by R. H. Thurston.

	Quantity in Milligrams.	Pressure on Bearing per Square Inch.	Number of Revolutions per Minute.	Time in Minutes till the Bearings "Squealed."	Total No. of Feet of Friction Surface Travelled.
Best sperm oil	335	60 lbs.	2,000	51	33,360
Best quality of lubricating grease.....	335	60 lbs.	2,000	51	33,360
Same grease containing 15 per cent. graphite	335	60 lbs.	2,000	293	194,941

G. W. DE T.

32. *Application of Mazout for Firing Locomotive Boilers.* **H. Guérin.** (Génie Civil, 41. pp. 238–239, Aug. 9, 1902.)—The value of Mazout, which is extensively used for firing locomotive boilers in Russia, is discussed. This substance is a distillate of naphtha which comes over after the separation of benzine and kerosine. Its flash-point varies from 80° to 170° C., and its calorific value is about 10,600 calories per 1 kg. When properly burned it leaves no soot in the fire-box. It is best used by injection through a pulverising nozzle from which it is sucked by a steam blast. It is estimated that 100 kg. of Mazout is equal to about 140 kg. of good coal for steam raising. C. R. D'E.

33. *Air Navigation.* **C. Chavoutier.** (Revue Scientif. 17. pp. 751–754, June 14, 1902.)—Deslandres had criticised Armengaud's trajectory of the Paris ascent of Santos-Dumont [see Abstracts Nos. 391, 551, and 1596 (1902)], pointing out that the trajectory can be determined photographically from the

Digitized by Google

landscape and the apparent size of the balloon. The author objects that the method is unreliable on account of perspective effects, and because the size of the balloon varied, especially as a compensating balloon was applied by Santos-Dumont. H. B.

34. *Torres Dirigible Balloon.* (Locomotion Automobile, 9. pp. 553–556, Aug. 28, 1902.)—The author investigates the question of the stability of a dirigible balloon, and proposes a construction in which the balloon is approximately cigar-shaped but of special cross-sectional form with a view to increasing its stability. The motor is mounted close up below the balloon, and drives a propeller at one end of the balloon by means of a long belt having a quarter turn. C. R. D'E.

REFERENCES.

35. *Steam Turbine at Hartford.* (Power, N.Y. 22. pp. 1–3, July 1902.)—This paper contains a detailed illustrated description of the steam turbine forming part of the 15,000-kw. unit at the Pearl Street Station of the Hartford Electric Light Company. It is found to carry a load of over 2,000 kw. with no indications of distress and with little loss of efficiency. G. W. DE T.

36. *Engine Safety Stopping Devices.* **J. F. Hobart.** (Amer. Electn. 14. pp. 352–353, July, 1902.)—This is a description of several mechanisms for quickly closing the steam valve of an engine, to be actuated automatically if the engine races, or by hand at any time. H. R. C.

37. *Gyrostatic Action and Engineering Design.* **W. R. Kelsey.** (Elect. Engin. 30. pp. 86–87, July 18, 1902.)—After a brief elementary discussion of the theory of gyrostatic action, the author gives an instance, in the case of a flywheel, in his own experience, showing that gyrostatic forces may obtain magnitudes rendering them worthy of attention from the designers of machinery subject to their influence. G. W. DE T.

38. *Flue-fired Superheaters.* **H. Cruse.** (Electrical Times, 22. pp. 295–296, Aug. 21, 1902.)—This paper is a collection of notes on the construction and working of superheaters, especially the flue-fired variety. The destructive agencies to which superheaters are exposed are first pointed out, and subsequently the paper contains instructions on many practical details of the construction and working of these superheaters. F. J. R.

39. *Mechanical Road Traction.* **A. E. A. Edwards.** (Mech. Eng. 9. 607–609, May 3, 1902. Abstract of paper read before the Birmingham Association of Mechanical Engineers.)—After a brief historical sketch, the author discusses critically the conditions of motor car operation ; the relative advantages of steam, electric, and petrol motor cars ; and the various component parts. G. W. DE T.

Digitized by Google

GENERAL ELECTRICAL ENGINEERING.

40. *Electrolytic Recovery of Copper from Low-Grade Ores.* **N. S. Keith.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 843–851, June–July, 1902.)—The author in this paper describes a wet electrolytic extraction process devised and used by him for treating ores from a mine near to New York City. The ores from this mine averaged 2 per cent. copper, and contained 8 to 10 per cent. water. The ore is dumped as it comes from the mine into a Gates type of crusher driven by electric power, and is broken down to ¾–1-in. pieces. The ore then passes to a steel hopper bin, holding 400 tons, in which the moisture is removed by an ascending current of hot air. From this bin the ore passes to crushing rollers, and it is then passed through a No. 30 wire cloth sieve. The powdered ore is next roasted in a mechanical furnace with rotating arms, heated by coal, in order to expel the sulphur. The capacity of this furnace is 125 tons of ore per twenty-four hours. The crushed and roasted ore is next charged in the heated state direct into the lixiviating tanks, where it is treated with dilute sulphuric acid (5–15 per cent. H_2SO_4). These tanks are four in number, and are worked in series, in order to deliver a solution of uniform strength to the electrolytic cells. Each tank is 30 ft. in diameter by 6 ft. deep, and when fully charged holds 125–150 tons. The electrolytic vats are of wood lined with lead, and are worked with the electrodes coupled in parallel, and the vats themselves in series. They are arranged in six rows of 21, and the electrolyte is caused to flow through the whole series of vats by aid of pumps and gravitation. The current density is diminished towards the end of the series by increasing the number of electrodes. Lead is used for the anodes, and thin copper or lead sheets for the kathodes. Each vat requires an e.m.f. of 1·87 volts, 1·60 volts of this being due to the potential difference at the two electrodes of the cell. The deposition of copper causes the iron present in the solution to assume the ferric state, and on lixiviating fresh ore with the exhausted electrolyte this salt acts as a solvent. Should CuO be present in the roasted ore, Fe_2O_3 is precipitated in the lixiviating vats, and the electrolyte is thus purified. The author was unable to give any figures for the costs of the process, as financial troubles had caused its suspension at the works referred to. He estimates, however, that the costs will not exceed $2·50 per ton of ore treated. J. B. C. K.

41. *Finance and Design of Electrolytic Copper Refineries.* **A. Philip.** (Electrician, 49. pp. 597–599, Aug. 1; 679–681, Aug. 15; 716–718, Aug. 22; 797–799, Sept. 5; and pp. 913–915, Sept. 26, 1902.)—In this series of articles—extracted from a forthcoming work on the subject—the author deals very fully with the costs of electrolytic refining, and considers the following items of capital and current expenditure in detail:—*Capital Expenditure.*—(1) Cost of offices. (2) Cost of refinery buildings. (3) Cost of power-plant. (4) Cost of dynamos and switchboard. (5) Cost of electrolytic vats. (6) Cost of electrolytic solution. (7) Cost of copper anodes. (8) Cost of copper in stock and leads, &c. (9) Cost of circulating and purifying plant. *Current Expenditure.*—(1) Interests on capital, depreciation and repairs. (2) Labour. (3) Cost of melting refined copper. (4) Fuel. (5) Salaries of management and clerical staff. (6) Ground-rent. Basing the estimates under each head-

Digitized by Google

ing upon actual working figures, so far as these can be ascertained, the author has worked out costs formulæ, in which T (the annual output of copper in tons) and D (the current density employed in amperes per sq. ft.) are the two chief variable factors; while P (the price of anode copper), P′ (the selling price of refined copper), S (the price of copper sulphate), and *t* (the thickness of the anode plates), are factors of lesser importance. For a refinery using anode copper at £70 per ton, and producing 1,000 tons refined copper per annum, the author estimates by this method a total capital expenditure upon plant of £11,225. Following the same method in estimates of the current expenditure and profits for a refinery working under predetermined conditions, the author arrives at a formula which can only be understood if read and studied in conjunction with the original context. In his final article Mr. Philip discusses the questions of current density, vat arrangement, size of vats, and voltage of dynamos, and approves the tendency noticeable in the most modern refineries, to increase the number of vats worked in series and the size of the same to the highest practicable limit. J. B. C. K.

42. *Electrical Manufacture of Peat Fuel.* (Engineer, 93. pp. 633–634, June 27, 1902.)—An illustrated description of the Peat Fuel Works at Stangfiorden, Norway. The process used is that patented by Jebsen, and 640 h.p. derived from water, is now utilised in the manufacture. The wet peat is brought to the works in lighters of 100 tons capacity, and is discharged by mechanical power. The peat is then submitted to pressure to remove the excess of water, and is passed in the form of moulded blocks to the drying plant, which consists of long tunnels heated by hot gases, through which the peat is slowly passed on shelf-waggons of special design. The final operation consists in distillation in closed retorts heated by internal resistance coils. The process yields a dense and compact mass, with a specific gravity of 0·30 in the broken condition and a calorific value of 7,250 thermal units. An analysis made by the authorities at the Christiania Hochschule gave the following mean composition :—

Carbon	Hydrogen	Oxygen	Nitrogen	Sulphur	Ash	Moisture
76·91	4·64	8·15	1·78	0·70	3·00	4·82 per cent.

The average yield of 100 kilos. of the air-dried peat is as follows :—Peat fuel, 33 per cent.; peat tar, 4 per cent.; tar water, 40 per cent.; gaseous products, 23 per cent. The gases obtained from the retorts are used for heating the drying tunnels. J. B. C. K.

43. *The Edison Storage Battery.* **H. F. Joel.** (Elect. Rev. 50. pp. 1041–1044, June 20, 1902.)—In this paper, the author discusses very fully the claims made in the various Edison patent specifications referring to the iron—oxide of nickel battery. He points out that the disadvantages to which it is subject are—the low e.m.f.'s, necessitating double the number of cells that a lead-lead battery requires; the use of caustic soda; the comparatively expensive elements; and the complex and expensive mechanical construction. The advantages claimed for it, on the other hand, are—great durability and long life, it being claimed that there is no appreciable waste in the elements during charge and discharge; little or no action on the metal-containing cells and connections; and a high output in comparisonwith its weight. The author considers it worth the serious attention of all interested in the future of electric vehicles. G. W. DE T.

Digitized by Google

44. *The New American Turbine.* **Pfarr.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 845–852, June 7, 1902.)—In this article the results obtained by the author, after an exhaustive series of experiments, with a 16-in. "new American turbine" are given, and differ from the results obtained by the Holyhoke Water Power Company. The efficiency of these turbines are, according to the author's results, not so high as presupposed. The difference in system employed for testing may account for the variation in the results obtained. The article is fully illustrated with diagrams, &c. L. G.

45. *Insulated Lines in India.* **K. A. Scott-Moncrieff.** (Inst. Elect. Engin., Journ. 31. pp. 371–379; Discussion, pp. 379–387, 1902.)—The insulation of bare wires on insulators varies owing to the humidity of the air, the effect of which is increased by spider's webs. Vulcanised indiarubber as an insulator did not prove a success in Calcutta, at 1,300 volts. In consideration of the heavy rainfall, difficulty would be met in draining a culvert system. A solid system, in which the cables, insulated with vulcanised bitumen, are laid upon wooden bridges in a cast-iron trough, was tried. The drawback of iron troughing is that a fault rapidly becomes a real short circuit, so much so that in some cases several feet of cable have disappeared through this cause. Faults also develope at the bridge-pieces. In every case where faults developed it was at a bridge-piece which came at the junction of two troughs and where there was a subsidence of the ground. The author thinks that the bitumen cracks at a weak point instead of bending gradually. The only other source of trouble has been where the bitumen was poured into the troughs when boiling. The surface rapidly cooled and prevented the steam escaping, thereby making a spongy casting. *For house circuits.*—Owing to the humidity of the air surface, leakage on switches, cut-outs, and other fittings is much increased. Some damage results from surface leakage destroying the metal parts of switches by electrolysis. Insufficient insulation of switch handles, even if ebonite, on a main switch on a 230-volt alternating circuit has given some trouble. The wiring in the mills around Calcutta was largely carried out with conductors insulated with a little pure rubber, protected by cotton. Even with such low-class work little or no trouble has occurred. The failure of wires covered with good rubber is due to exposure to damp and heat and no ventilation. The wires are shut up in a casing, and the whole becomes wet and rots. No insulation will stand under these circumstances. Interior conduits made of 1-in. compo-pipe has stood well for the last six years. Large pipes should be used, so that the insulation may be ventilated. M. O'G.

46. *Power for Railroad Repair Shops.* **R. W. Stovel.** (Mech. Eng. 10. pp. 14–16, July 5, 1902. Paper read before the Railway Club of Pittsburg.)—The author assumes as demonstrated that the best system in every way is one with electric distribution from a central generating station. He then discusses the requirements which determine the details of the method in which this should be carried out. For electric cranes, the best system available is direct current of 220 or 500 volts. The use of alternating current would increase the cost by about 25 per cent. For constant-speedtools, alternating motors are preferable. He then considers variable-speed tools, whose efficiency depends on the depth, width, and speed of cut, and, of course, on the operator. With the old system of cone-driving, the increment of speed from cone-step to cone-step is nearly always over 50 per cent. Assuming that the proper speed in any case can be determined to within,

Digitized by Google

say, 10 per cent., an individual variable-speed motor drive will be indicated. This will mean a 220-volt direct-current system, which was also indicated for electric crane work. The author then considers in detail the cost of power which would be consumed by shafting, and the saving which would be effected by the use of variable-speed tools capable of close-speed regulation. Illustrated curves founded on machine shop experience are given. The author assumes that with cone-driving the average speed increments are 60 per cent. for small tools, and 40 per cent. for large ones. He also assumes that half the total time is cutting time. The general conclusion arrived at is that individual motor-driving is advantageous for all variable-speed tools which are busy throughout the shop year, regardless of their power consumption; also that it will pay to change over existing shops to the individual motor-drive system. G. W. DE T.

47. *Electric Winding Machinery.* C. Köttgen. (Zeitschr. Vereines Deutsch. Ing. 46. pp. 701–711, May 17, and pp. 761–768, May 24, 1902. Paper read before the Bezirksverein.)—The author describes two winding machines. The first has cylindrical drums, and lifts 2,800 kg. at the rate of 3·4 m. per second. It is driven by a polyphase motor of 120 h.p., which is geared to the driven machinery in the ratio of 1 to 7. The second lifts 800 kg. at a maximum rate of 7 m. per second, being driven by two shunt motors, directly coupled to the drum, which run at 72 r.p.m. The speed is controlled by a starting resistance in series with the machine, and by a second resistance in parallel with the armature. In this way a speed of 10 cm. per second can be reached, and the adjustment of stoppages at the various points is facilitated. Several diagrams are given showing the connection, in the case of this second machine, between the power supplied, the speed, and the time taken on the journey with loads varying from 650 kg. to 1,180 kg., and points are discussed in connection with the storage of energy, either by accumulators or flywheels. The author deals further with the cost and conveniences of an electrical installation as compared with steam, and also with the friction arising from the rope under various conditions with Koepe pullies constructed of different materials. A large number of diagrams are given showing the general arrangements that are possible, and the most convenient methods of connecting the motors to the work, and methods are considered which conduce to minimising the electrical losses which are connected with the frequent starting and stopping of the motors. Finally figures are given which show the great economy which has resulted in certain mines from the use of electrical machinery in place of steam. W. H. S.

48. *Electrically-driven Winding Engine.* (Engineering, 74. pp. 12–18, July 4, 1902.)—This article contains two drawings of a winding engine that was on view at the Düsseldorf Exhibition. It is built for the Gelsenkirchen mines, and it is intended to lift a working load of 4 tons 8 cwt. from a depth of 1,640 ft. at a maximum speed of 66 ft. per second. It is driven by two continuous-current motors, each of 1,400 h.p.; these are keyed direct on the main shaft on each side of the driving drum. Two motors are used, partly in order to adopt the series-parallel control, and partly to avoid a total breakdown. By gradually switching in a storage battery and altering the excitation of the fields of the magnets, the speed can be varied from 6 ft. 6 in. to 65 ft. 8 in. per second, and for inspecting the rope the speed is reduced to 1 ft. per second. A diagram of the electrical connections is given. W. H. S.

Digitized by Google

49. *Electrically-driven Winding Engines.* (Engineering, 74. pp. 186 and 188–189, Aug. 1, 1902.)—Two winding engines are here described with drawings, diagrams of connections, &c. The first lifts 100 tons of coal per hour from a depth of 2,296 ft., and is driven by a three-phase 2,000-volt motor. The speed is regulated by a liquid resistance, consisting of a solution of soda, in series with the armature. The starting lever first closes the main switch, and then opens a valve connecting with the soda tank. A small pump then fills the tank at a predetermined speed, and acceleration takes place accordingly. The motor is directly connected to the pulley shaft. The second engine lifts 60 tons an hour from a depth of 722 ft. The motor is also directly connected to the drum shaft, and runs at a maximum speed of 80 r.p.m. The speed is varied by altering the excitation of the main generator. The generator is separately excited, and the controller of the winding engine inserts resistance in the circuit of the exciter, so that the pressure of the exciting current for the main generator can be varied from zero to 240 volts. In this way the pressure of the generator can be gradually increased, as also the speed of the winding engine. W. H. S.

50. *Electrically-driven Pumps at Horcajo.* (Engineering, 74. pp. 72–75, July 18, 1902.)—The description of the pumping plant at these Spanish mines, by Heerwagen [see Abstract No. 177 (1902)], is translated, and a plan of the scheme is given. The quadruple centrifugal pumps made by Messrs. Sulzer are described. The pumps are driven by three-phase motors of Brown, Boveri & Co. Electrical details not given in the previous Abstract will now be added. The stators bear nine coils, each of 42 turns, the three coils of each phase being connected in series, the three phases themselves in mesh fashion. The rotor carries twice 180 flat copper rods in 180 holes, arranged in two layers. They are connected so that six rods in series are short-circuited, thus giving 60 circuits around the armature. The short-circuited armature was suggested by Heerwagen and has answered very well. Centrifugal pumps can start under a zero torque which gradually increases and can be brought up to full speed when full of water in 100 seconds. The motors are started with the aid of an auto-transformer which gives 400 volts, the primary tension in generators and cables being 1,000 volts. The auto-transformer being switched in, the first motor is joined to the starting bars. It takes at first from 200–240 amperes, but very rapidly comes up to synchronism. The moment is marked by a sudden drop in current strength; the connections are then changed over to the main bus-bars, so that the motor continues to run under full voltage. The second motor is then started in the same way, and the auto-starter is finally cut out. W. W. H. G.

51. *Power Consumption of Electric Elevators.* **G. F. Sever.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 885–890, June, 1902.)—The results of twenty tests, selected from the most characteristic installations in New York, favour the use of direct-current motors, except in cases where its advantages can be offset by the decrease in repairs and attendance, due to greater simplicity of control and the absence of a commutator, where alternate-current motors are employed. G. W. DE T.

52. *Electric Service Elevators at the Paris Post Office.* **V. Belugou.** (Génie Civil, 41. pp. 203–205, July 26, 1902.)—Owing to the special conditions existing at the Paris Post Office an absolutely reliable and rapid system of elevators is necessary. The conditions are fully described in this article. Formerly

Digitized by Google

hydraulic lifts were used, which were very expensive to work, and strictly limited the number of journeys. Two sets of six lifts each are now installed, each consisting of an electrically-driven winding drum with counterbalanced cage. The counterbalance is equal to the weight of the cage plus half the weight of the load. The load is from 800 to 400 kg. and the speed about 40 cm. per sec. (about 6 to 8 cwt. at about 80 ft. per min.). The motors are of the gramme type with compound wound magnets, the series field assisting the shunt. The object of the series winding is to reduce the starting current, to produce powerful starting torque. The lift is actuated by means of a three-point switch. When in the central contact no current can pass; when on the right-hand contact, current passes through a relay which closes the ascending circuit; and when on the left-hand contact the descending circuit is closed through another relay. The circuit is first closed through a resistance, which is automatically cut out when the motor has attained a given speed. On stopping the lift, by returning the handle to the middle position, the motor armature is short-circuited, thus acting as a brake. Two coupled-direct 30-kw. generating sets, each of which is sufficient for the whole installation, supply the necessary current. The electric elevators have been working for four years with absolute regularity, and have permitted addition to the general traffic which would not have been possible with the old hydraulic equipment. As to economy, besides other advantages, there is a saving of more than 50,000 francs a year (say £2,000) in coal and labour. The cost of repairs has been trifling. With 400 journeys daily all that has been necessary during four years is the rewinding of a few relay coils. A diagram of connections, plans, and sections of the lift, and details of the relays, &c., are given. F. B.

53. *Soulanges Canal Electric Plant.* (Canad. Elect. News, 12. pp. 93–97, June, 1902.)—Owing to the fact of a good water power being available on the canal, it was decided to install an electric plant for the operation of the locks, sluices, and bridges, and to light the canal throughout its entire length. On account of the length of the canal, the alternating current three-phase system was adopted. There are two wheel pits, in each of which are installed two pairs of Victor turbines on one horizontal shaft, operating under a 20-ft. head at 225 r.p.m., and discharging into the Grease River, which acts as a tail-race. Each set of wheels is furnished with a Geisler governor. To each water-wheel unit is coupled a three-phase revolving field, 60-cycle generator of 264 kw. capacity at 2,400 volts, furnished by the Canadian General Electric Company, each being set on a concrete foundation capped by heavy dressed stone. Two four-pole exciters are furnished, each of 17 kw. capacity at 125 volts, being sufficient to excite the fields of both generators. These are driven by belts from the main water-wheel shafts. Crossing the canal at intervals are five electrically operated bridges. The motors and controlling apparatus are contained in a cabin at the side of each bridge. The motors are of 2-h.p. capacity, operating at 220 volts, and are geared to the mechanism for turning the bridge. Between the electrical mechanism and the bridge gearing a flexible friction is interposed, which is operated by a lever, and acts either as a clutch or a brake as occasion requires. The bridges each weigh upwards of 100 tons, and the mechanism is designed to open or close them within ten minutes. Power is conveyed to the bridge, by means of submarine cables, from transformers placed on one of the line poles adjacent to the bridge. The lock gates and sluice valves are operated by the Canadian General Electric Company's three-phase 220-volt constant-speed induction motors in the following manner: The lock gate motors are of 8-h.p. capacity,

Digitized by Google

and are connected to the pinion which operates the rack by a pair of gears. At one point, however, is interposed a friction device which is so arranged that by operating a lever two friction-pulleys can be brought into contact, thus applying the power to move the gate, and by reversing this lever, a powerful brake is applied, which is used to arrest the motion of the gate, and thus prevent it striking with more than necessary force the mitre sill when closing, or the recess when opening. The motor can be reversed in a few seconds in case of emergency. The electrical apparatus installed along the canal is very effectively protected against lightning, lightning arresters of the Canadian General Electric Company's short-gap type being installed at each lock, and at every point where cables pass under the canal for lighting, power, or telephone services. The operation of the sluices, locks, and bridges by electricity has been found to result in a saving of labour equal to 50 per cent., there now being required for the operation of the locks only two men instead of four as previously. G. W. DE T.

54. *Crane Brakes.* **E. Rosenberg.** (Zeitschr. Elektrotechn., Wien, 20. pp. 353–357, July 20, 1902.)—This article consists of a discussion of the various forms of brakes employed in electrically driven cranes. Three types of brake are dealt with, namely, the electro-mechanical brake, the eddy-current brake, and the brake produced by running the motors as generators. In the particular form of electro-mechanical brake described, the electromagnet which applies the band-brake to the lifting-barrel is excited through a local circuit connected to an auxiliary carbon brush bearing on the motor commutator between the two main brushes. The current supplied to the magnet is thus delivered at a low potential, and a more efficient design of magnet may therefore be employed. The author points out that this type of brake is not the most effective in stopping a running load, and recommends the use of the last of the three types above mentioned, in combination with a hand-brake, on account of its cheapness and simplicity in operation. The article is illustrated, and curves are given of tests of an eddy-current brake. J. G.

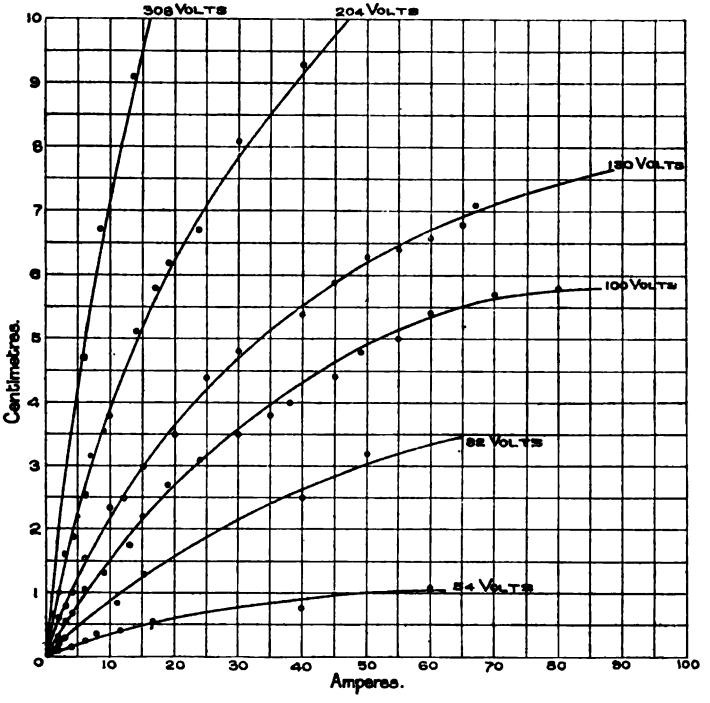
55. *Electrically-driven Hammer.* (Mech. Eng. 10. p. 114, July 26, 1902.)—The hammer is to be used for chipping, caulking, &c., and is made by the Stow Flexible Shaft Company, of Philadelphia. The power is transmitted by a flexible shaft, and a reciprocating motion is given to the hammer-head, which gives a rapid succession of blows to the chisel, shocks and vibration being avoided by the insertion of springs between the working parts. A drawing is given. W. H. S.

56. *The Highfield and Beeton Speed-indicator.* (Electrician, 49. pp. 703–704, Aug. 22, 1902.)—This indicator, which is made by Elliott Bros., of London, comprises a small magneto-generator, mounted on a flanged steel spindle, secured by set-screws to the end of the motor-shaft of a motor vehicle. The bipolar field is produced by two bent permanent magnets, shunted by an iron piece and mounted in a cup-shaped casing, which bears the brushes, and is coupled by a link to a fixed point on the vehicle, so as to prevent it from rotating. This casing is mounted on ball-bearings on a sleeve which fits over the steel spindle above mentioned, and is pinned thereto so as to rotate therewith. The armature is arranged outside the pole-pieces of the field magnet, and is mounted in a second cup-shaped casing, which is formed on one end of the sleeve above mentioned, and fits loosely on to the first casing, so as to

Digitized by Google

exclude dust without causing friction. The current from the generator passes to one or more voltmeters, which can be calibrated to indicate the speed of the vehicle in miles per hour, and can be made to furnish a continuous record on a travelling strip of paper. In the latter case the indicator is mounted in a special anti-vibration frame. The original paper is illustrated.
C. K. F.

57. *Sparking in Switches.* **A. Russell** and **C. Paterson.** (Inst. Elect. Engin., Journ. 31. pp. 1204–1217, June, 1902.)—When a direct-current circuit is quickly broken a spark ensues. In the Fig. are given lengths of sparks at various constant voltages. The following are the conclusions arrived at: (1) The spark at break ought to be taken as a guide to the rating of a switch



for use on direct-current circuits. (2) The shape of the terminals does not make much difference to the length of the spark. (3) The effect of increasing the speed of break above that ordinarily employed is small. (4) The effect of a double break is to make the lengths of the spark the same as the length of a spark with the same current at half the voltage. (5) The difference in the length of the spark when copper, steel, or zinc is used is not great. (6) For small double-break switches for use on circuits of 200 volts and upwards, when the trailing spark just fails to bridge the air-gap. The air-gap should be double the distance at which a permanent arc can be obtained. (7) For double-break switches for large currents under the same circumstances the air-gap should be more than double the arcing distance. M. O'G.

Digitized by Google

58. *Iron Wire Resistances for Large Currents.* **F. Loppé.** (Ind. Élect. 11. pp. 846–848, Aug. 10, 1902.)—The iron wire resistances made up into spirals are immersed in water, the spirals being placed vertically, and each contained in a partitioned box open at both top and bottom ends; the whole is placed in a large tank of water, the surface of the water coming 10 cm. above the top of the partitioned boxes. The boxes are supported on legs so as to be 15 cm. above the bottom of the containing tank. This arrangement is found to produce a good circulation of the water, the partitions acting as chimneys.
E. C. R.

59. *The Partridge Sparklet Fuse.* (Electrician, 49. pp. 435–436, July 4, 1902.)—The sparklet is a small steel capsule containing liquid carbonic acid. In the fuse it is so placed that if an arc is formed the cap of the sparklet is melted off, and the carbonic acid blows out the arc. A drawing is given showing the details of construction. The fuse wire, which is about 9 in. long for a 10,000-volt arc, is laid between mica slips in an earthenware trough, about half an inch being exposed at each end. A sparklet fits through a hole in the porcelain screen at each end, making contact with the terminal of the fuse by a spring contact. The other end of the sparklet is above the exposed part of the fuse wire, and as soon as the arc rises the caps of the sparklets are melted off, and the carbonic acid blows out the arc. The arrangement of spring contact and porcelain screen ensures the melting of the front end of the sparklet, and when the fuse blows the earthenware trough and the terminals are uninjured. W. H. S.

REFERENCES.

60. *Electric Canal Towage in Belgium.* (Elect. World and Engineer, 40. pp. 161–162, Aug. 2, 1902.)—The present article gives some particulars as to the financial results obtained from the working of the canal between Brussels and Charleroi. [See also Abstract No. 2114 (1900).] W. H. S.

61. *Electric Rock-boring Drills.* **E. Heubach.** (Zeitschr. Elektrotechn., Wien, 20. pp. 121–125, March 9, and 145–150, March 23, 1902. Paper read before the Elektrotechn. Verein, Jan. 22, 1902.)—The paper describes with illustrations a number of different types of electric rock-boring drills. [See also Abstract No. 181 (1902).] G. W. DE T.

62. *Uniformity in the Electrical Engineering Courses in the United States.* **S. Sheldon.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 767–770, May, 1902.)

63. *Technical Training.* **E. B. Raymond.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 785–789, May, 1902.)

64. *The Training of Engineers.* **C. P. Steinmetz.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 761–766, May, 1902. (Presidential Address). G. W. DE T.

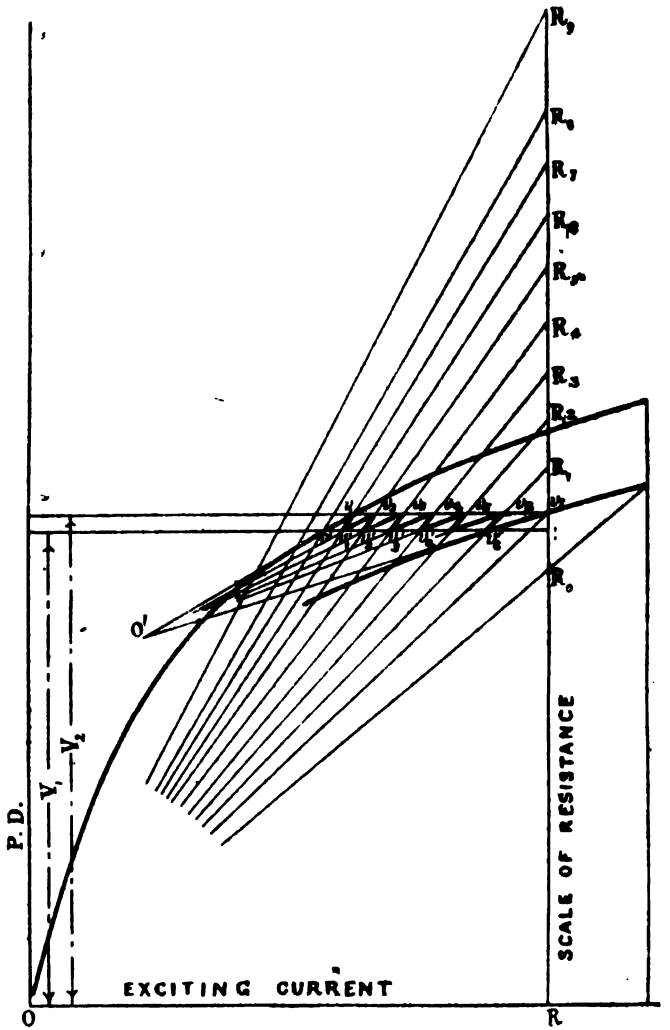
65. *Teaching of Electrical Engineering in the Technical High Schools of Charlottenburg (Berlin) and Darmstadt (June, 1901).* **D. K. Morris.** (Inst. Elect. Engin., Journ. 31. pp. 1200–1203, June, 1902.)

66. *Electricity in Naval Construction.* **L. Gerard.** (Soc. Belge. Élect., Bull. 19. pp. 448–463, July, 1902.)—The paper is mainly devoted to a description of the applications of electricity on board the *Kronprinz Wilhelm*, recently constructed for the North German Lloyd Company. G. W. DE T.

Digitized by Google

GENERATORS, MOTORS, AND TRANSFORMERS.

67. *Design of Field Rheostats for Shunt-wound Dynamos.* **G. J. Erlacher.** (Elektrotechn. Zeitschr. 23. pp. 556–557, June 19, 1902.)—The author gives the following elegant graphical method for finding the resistances of the con-



secutive sections of a field rheostat. In the Fig. the upper characteristic gives the relation connecting exciting current with p.d. on open circuit, and the lower characteristic gives the same relation at full load. These characteristics are supposed to be known, and the problem is to design the field rheostat so that as the load varies the p.d. may be kept within the limits

Digitized by Google

V_1 and V_2. The machine running on open circuit, and all the resistance being in, we start from the point v_1 in the Fig. As the load increases, the p.d. gradually falls, until the point v_1' is reached; v_1v_1' is clearly a straight line passing through the origin, for during the change from v_1 to v_1' the total resistance of the shunt-circuit, and hence the ratio of p.d. to exciting-current, is constant. When the point v_1' is reached it becomes necessary to reduce the field resistance; we then pass from v_1' to v_2, along a curve which forms part of a characteristic for the intermediate load considered. In order to avoid the necessity of having to determine a large number of characteristics corresponding to intermediate loads, it may be assumed that the sections $v_1'v_2$, $v_2'v_3$, &c., of the characteristics are portions of straight lines radiating from O', the intersection of v_1v' and v_7v_6' produced backwards. This assumption enables us to determine the zigzag line shown in the diagram. By taking any convenient ordinate, such as RR_9, as a scale of resistance, we get the values of the consecutive resistances by determining the intersections of $v_1'v_1$, $v'v_2$, &c., with this ordinate. In the diagram, RR_9 is the resistance of the field coils when warm, and R_0v_7 represents that portion of the rheostat which always remains in circuit so long as the machine is not overloaded; v_7R_1, R_1R_2, &c., correspond to the consecutive sections of the rheostat. The sections R_6R_7 and R_7R_8 (each $= R_5R_6$) are intended for regulation purposes before the coils become hot, and the last section R_8R_9 is intended for lowering the e.m.f. before switching off. A. H.

68. *Standardising Electrical Machinery.* (Elektrotechn. Zeitschr. 23. pp. 504–507, June 5, 1902.)—This paper contains the regulations adopted in June, 1902, by the German Association of Electrical Engineers. They are practically the same as those which were provisionally adopted in 1901, and discussed [see Abstract No. 1232 (1902)], except that an appendix is added in which it is suggested that 25 and 50 should in future be taken as the standard frequencies. Standard voltages are also suggested, varying from 115 to 550 volts for direct-current generators, and from 115 to 5,250 volts for alternate-current generators, with corresponding motor voltages. G. W. DE T.

69. *A 25,000-volt Dynamo.* **B. Böhm-Raffay.** (Zeitschr. Elektrotechn., Wien, 20. pp. 807–809, June 22, 1902.)—This machine, which gives 1 ampere at 25,000 volts, has been constructed for the purpose of testing the insulation of the transmission line between St. Maurice and Lausanne. The armature, which is stationary, has an internal diameter of 580 mm., and a length of 300 mm. It consists of 48 Gramme coils, each with 500 turns of silk-insulated wire, 0·5 mm. in diameter, the total resistance being 700 ohms. The commutator consists of 96 air-insulated segments, and is connected by rotating brushes to stationary slip-rings. The rotating magnet has two poles, and is constructed of laminated iron. It takes 8 amperes at 80 volts, and revolves at 600 r.p.m. An air blast is brought into play on the brushes to prevent sparking; this, however, is unnecessary for outputs up to 0·8 ampere. W. H. S.

70. *Double-current Generators.* **E. T. Ruthven Murray.** (Elect. Engin. 30. pp. 10–13; Discussion, pp. 13–14, July 4, 1902.)—The alteration by the Board of Trade, a few years ago, of the limit of low-pressure supply to 500

Digitized by Google

volts has been to produce a large increase in the number of works supplying on the continuous-current system. But many of these are now finding the limitations of direct supply, and a flexible and economical method of dealing with the increase in area and output is found in high-pressure transmission to the outlying districts. The necessity for supplying beyond the economical limits of low pressure generally comes gradually; the double-current machine may be put in for use entirely as a continuous-current dynamo until the necessity for long-distance transmission requires it to be employed as an alternator, when it can be used to generate any desired proportion of alternating current. The author describes the principle on which the double-current generator is constructed, and gives a series of formulæ, illustrated by diagrams, which explain the relationship subsisting between the direct and alternating current and pressure in cases of single-phase, two-phase, and three-phase machines respectively. The fields may be arranged either for separate, shunt, or compound excitation; the first gives the best regulation for varying loads. Good governing and even turning moment in the engine are of great importance. Slotted core, drum-wound armatures give a better voltage curve than the usual monotooth alternator windings, and tend to minimise the demagnetisation of the fields due to lagging current. The problem of commutation is not an easy one, since the peripheral speed of the commutator must be kept within practical limits, and on the other hand the voltage between adjacent segments must not be excessive; it has, however, been successfully solved. By the use of the double-current machine where otherwise separate continuous and alternating machines would have to be put down, economy both in capital expenditure and running costs will result. Machines of this type are proposed to be used for the Mersey Railway, for Willesden, St. Pancras and Trafford Park; in America a large number are at present in use for both lighting and tramway service. Some details follow of two 300-kw. double-current generators which the author is putting down. The working pressure is from 480 to 550 volts on the direct-current, and about 280 to 330 volts on the alternating side; the machines are 12-pole, running at 250 r.p.m., at a frequency of 25. As regards the transmission of the alternating current, the transformers used are preferably connected in mesh rather than in star; at substations conversion to direct current is effected either by motor-generators, with induction or synchronous motors, or by rotaries; in this case step-down transformers will be required to feed the rotaries. The use of rotaries has the advantage both as regards efficiency and cost; and the overload capacity of machines of this type renders them invaluable in certain cases. In conclusion an application of double-current generators and rotaries for balancing a three-wire circuit is referred to, and various ways of regulating the pressure on the alternating side are described. *Discussion.*—**C. H. Wordingham** thought the difficulty of regulating the pressure made the motor-generator preferable to the rotary; he advocated the use of boosters where great variation of pressure was necessary. **W. B. Esson** would regulate the alternating pressure by boosting—this could be done by passing the current through an alternating armature in an excited field. He protested against conversion to direct current at all. **L. Andrews** considered that a stationary booster would do what was required. **Scott** gave some illustrations of American practice in regard to the use in power stations of alternating and direct current in combination, and stated that by the aid of the double-current generator many problems could be solved which were otherwise quite insoluble; and he thought that in this country it would be found of even greater use. B. P. S.

Digitized by Google

71. *Calculation of the P.D. Drop of Alternators.* **C. Westphal.** (Écl. Électr. 32. pp. 161–172, Aug. 2, 1902.)—There are two main problems solved in this paper: (1) the determination of the p.d. drop of alternators, and (2) the calculation of the excitation necessary to compensate for this drop. The principle of the method employed may be described as follows: We can consider the air-gap of the machine as being the seat of the magnetising and demagnetising forces, *i.e.*, where the "ampere-wires" of the field magnets and armature counterbalance. Consequently the air-gap only is considered first, and since the "ampere-wires" necessary to magnetise the iron are the same for every line of induction it depends only on the total flux, and can be added directly to the "ampere-wires" required for the air-gap. It is pointed out that every theory that considers only the resultant of the ampere turns assumes a constant reluctance, and gives a false picture of what is taking place. By assuming a suitable expression for the magnetising force of the revolving field magnets at a point in the air-gap he shows that the problem reduces to solving two simultaneous differential equations which are known as the fundamental equations of dynamic electricity. Assuming a Fourier's series for the armature current and a suitable expression for the exciting current he solves these equations. The solutions are very lengthy, but he shows that they are not difficult to apply in practice. A full solution is given for a 35-kw. single-phase machine, which agrees very closely with the experimental results. A. R.

72. *Engine Speeds for Direct-connected Alternators.* **E. Knowlton.** (Elect. World and Engineer, 40. pp. 125–126, July 26, 1902.)—Starting with the assumption that the phase displacement between two alternators should, for successful parallel operation, not exceed 5 (electrical) degrees, a calculation is given and a formula derived for the flywheel effect (weight of revolving part multiplied into the square of the radius of gyration) which is shown to vary inversely as the fourth power of the r.p.m. The amount of flywheel effect necessary to prevent too great a variation in speed during the interval between a change of load and the final adjustment of the regulator to that load is a different problem entirely; the flywheel power required to prevent too great cyclical displacement is generally more than enough to provide for this latter requirement. The paper concludes with a comparison of the costs of flywheel and separately driven alternator sets; the former have the advantage, and more especially when the voltage and speed are high. B. P. S.

73. *Self-exciting Induction Alternators.* **A. Heyland.** (Soc. Int. Élect., Bull. 2. pp. 541–565; Discussion, pp. 565–591, July, 1902.)—The author gives curves relating to the performance of his compensated induction motors and compounded self-exciting induction generators [see Abstracts Nos. 2475 (1901) and 567 (1902)]; the principles underlying the construction of these machines are explained, and a compounded induction alternator is illustrated. *Discussion.*—**Boucherot** compares the induction generators of Heyland and Latour [see Abstracts Nos. 1285 (1902) and 2166 (1902)], pointing out that they are identical in principle. He criticises these machines, saying that one of the advantages of alternating currents—the possibility of using machines having no commutators—is lost. He expresses the opinion that the advantage gained by increasing the power-factor is more than counterbalanced by the increased complexity and cost of construction. **Latour** reviews the theory of the self-exciting induction generator, more particularly with reference to the difference between Heyland's machine and his own. In his reply, **Heyland** insists on

Digitized by Google

the difference between the two machines, and states that the experimental results obtained clearly bring out such a difference of principle. He further considers the relation of Görges' motor to the self-exciting induction machine. A. H.

74. *The Normal Saturation of Alternator Fields.* **R. Beattie.** (Electrician, 49. pp. 479–480, July 11, 1902.)—An alternator is considered good if it has a small percentage voltage drop from no load to full load, and if the rate at which the voltage increases as the exciting current is increased is large. The author calls this latter rate the voltage adjustability, and he defines the regulation efficiency of the machine as the ratio of the voltage adjustability to the percentage voltage drop. In general this regulation efficiency will be a maximum for some particular value of the exciting current, and he defines this excitation as the one that produces normal saturation. In some cases there are practical reasons for preferring to work at a higher saturation. Curves are drawn showing how the regulation efficiency of a small alternator increases from 0·08 when the exciting current is 0·17 of an ampere to its maximum value of 0·3 when the exciting current is 0·45 of an ampere. It then diminishes to 0·06 when the exciting current is 1·5 amperes. A. R.

75. *Alternators with Compensating Exciters.* **Boucherot.** (Soc. Int. Élect., Bull. 2. pp. 446–484, June, 1902.)—In order that the p.d. between the terminals of an alternator may remain constant at all loads, it is necessary for the flux produced by the exciting current to be proportional to—

$$\sqrt{(A + BI_1 \sin \phi)^2 + (BI_1 \cos \phi)^2} \quad \ldots\ldots(1)$$

where A and B are constants depending on the alternator I_1 is its armature current and ϕ is the phase difference between I_1 and the terminal p.d. In the author's machines the stator of the exciter is similar to the stator of an induction motor, and its windings are connected to the alternator terminals through the secondaries of a compensating transformer, the primary windings of which are in series with the mains. The rotor of the exciter has generally two windings, each of which is wound in a somewhat similar manner to the armature of a multipolar dynamo, but instead of the windings being equally distributed round the circumference an approximate sine curve distribution of the windings is made. The windings are so arranged that the phase difference between the e.m.f.'s induced in them is 90 degrees. Under these circumstances it is shown that when the ratio of the angular velocity of the stator field to the angular velocity of the rotor equals the ratio of the number M of the poles of the alternator to the number N of the poles of the exciter, then continuous current can be collected from the commutator of the rotor by means of M—N brushes, and it is proved that the intensity of this current is proportional to (1). It is also shown that the best position of these brushes is the same at all loads. The main disturbing causes are magnetic leakage in the alternator, the resistance of the primaries of the compensating transformer (since the p.d. on the line is wanted to be constant and not the p.d. at the machine terminals), and the variations of the speed with the load. The effect of leakage is to make the machine volts rise on an inductive load, and hence would not in general be detrimental. The other disturbing causes can be made negligible by slightly overcompounding the machine. The advantages claimed for the Boucherot system are the saving in the attendance required, the economy in construction, the fact that the exciter has not many poles or brushes, and that the high-tension windings are quite distinct from the exciting

Digitized by Google

coils. Alternators supplied with Boucherot compensating exciters run well in parallel, and heavy flywheels are not required. Descriptions and photographs of machines supplied with these exciters having velocities varying from 65 to 1,000 r.p.m. and producing pressures up to 3,200 volts are given. An interesting method of saving some of the energy wasted in frequently starting and stopping motors coupled on to heavy machines is given. Supply circuits of different frequencies are employed ; the motor is first connected to the circuit of lowest frequency, it is then connected to a circuit of higher frequency, and so on, the operations being done in the reverse order when stopping. At the Cambrai Sugar Manufactory three frequencies, 21, 35 and 50, are employed for starting and stopping the motors coupled on to the heavy sugar turbines. The machines are thus started more quickly, energy is saved, and excessive wear of the mechanical brakes prevented. The following table shows the energy saved by having circuits of different frequencies.

No. of Currents of Different Frequencies.	Waste on Starting.	Recovery on Stopping.	Total Waste.
1	1	0	1
2	0·75	0 19	0·56
3	0·67	0·29	0·38
4	0·62	0·35	0·28

A. R.

76. *Notes on Synchronising.* **J. M. Roman.** (Elect. World and Engineer, 39. pp. 1044–1046, June 14, 1902.)—Modern methods of synchronising alternators and converters on single and polyphase circuits are described. The necessary electrical connections to the various devices are clearly shown by diagrams. For example, the connections of a Lincoln synchroscope for putting two-phase machines in parallel are given [see Abstract No. 198 (1902)]. In modern practice the operation of synchronising is almost entirely automatic, and judging by recent patents inventors are endeavouring to make it completely automatic. A. R.

77. *Fire Risks from Station Transformers.* **G. P. Low.** (Journal of Electricity, S.F. 12. pp. 159–160, Aug., 1902. Abstract of a paper read before the Annual Convention of the Fire Underwriters Association of the Pacific, San Francisco, Feb. 20–21, 1902.)—The author first points out the distinction between "converters" and "transformers," and shows that the fire risks from the latter are distinct, and worthy of special study and attention. A transformer is, however, very similar in principle to a dynamo. In the latter a wire moves through a magnetic field, while in the transformer a magnetic field moves through a wire. A transformer which burns out has therefore centred behind it the whole energy of the power-house, and this explains the disastrous consequences which attend such mishaps. The voltage required from transformers is steadily rising with the increase in the distances to which power is being transmitted. A few years ago 10,000 volts was the maximum ; to-day 40,000 volts is being regularly used, and experimental trials have been carried out with 80,000 and 120,000 volts. This increase in voltage has rendered the use of oil for internal insulation imperative in high-voltage transformers. The few risks attending the use of oil for this purpose are more than outweighed by the advantages which oil offers. The chief risk

Digitized by Google

is due to the heating of the oil; at times a temperature 40° C. higher than that of the surrounding atmosphere may be attained. If a short-circuit occurs in such heated oil, the latter may be raised to its boiling-point, and explosive results will occur. Two improvements in transformer construction are necessary to minimise the risks arising from this cause. In the first place, transformer casings must be made of some substantial and durable material, in place of the thin sheet iron now in customary use. In the second place, the internal cooling pipes of the transformer must be so connected to the water supply that under no circumstances can any interruption in the flow occur. Under well-designed and arranged conditions of cooling, transformers have passed through the ordeal of a station fire without damage, since the water-flow served to carry off not only the internal but also the external heat. Finally, the risks arising from fire might be still further reduced by housing the transformers in a separate fireproof building. This, however, is a policy which, under normal conditions of work, is hardly called for. J. B. C. K.

REFERENCES.

78. *Testing Steam Dynamos.* **E. H. Rayner.** (Inst. Civil Engin., Proc. 148. pp. 3–23, 1901–1902. Paper read before the Manchester Association of Students, Feb. 20, 1901.)—The author here describes the methods of testing adopted at Messrs. Willans and Robinson's Rugby Works. An appendix gives details of the results obtained with a Willans compound non-condensing three-crank 360-i.h.p. engine and Siemens' two-pole dynamo. G. W. DE T.

79. *Predetermination of Armature Reaction.* **R. V. Picou.** (Soc. Int. Élect., Bull. 2. pp. 425–445, June, 1902.)—The author gives a complete method for the predetermination of armature reaction, taking account of magnetic leakage and self-induction, applicable to alternating and continuous-current machines. The paper is illustrated by a number of diagrams. R. B. R.

80. *Field Rheostats.* **R. Krause.** (Elektrotechn. Zeitschr. 23. p. 556, June 19, 1902.)—A letter supplementary to the articles noticed in Abstracts Nos. 1233 and 2332 (1902). A. H.

81. *Induction Motor Calculations.* **A. Lindström.** (Elektrotechn. Zeitschr. 23. pp. 521–522, June 12, 1902.)—From a vector diagram the author deduces various approximate formulæ for the induction motor. A. H.

82. *Heyland's Asynchronous Motor.* **Boy de la Tour.** (Ind. Élect. 11. pp. 245–249, June 10, 1902.)—The behaviour of Heyland's induction motor with a power-factor of unity [see Abstract No. 2475 (1901)] is studied by the author with the aid of a vector diagram. He first considers an ordinary induction motor, and then shows how the diagram is modified by the introduction of the commutator and brushes. The diagram is then applied to the design of such a motor. A. H.

83. *Induction Motors.* **H. S. Meyer.** (Electrician, 49. pp. 307–309, June 13, 1902.)—This is a discussion of the different characteristics of squirrel-cage and wound rotors, showing that the former may be employed of considerably greater sizes than is usually supposed. A. E. L.

84. *Sparkless Commutation.* **E. Dick.** (Elektrotechn. Zeitschr. 23. pp. 396–397, May 1, 1902.)—A letter dealing with the calculation of the permissible reactance voltage and the effect of the reversing field. A. H.

Digitized by Google

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING

ELECTRICAL DISTRIBUTION.

85. *Power Station Working.* **A. L. C. Fell.** (Tram. Rly. World, 12. p. 86, July 5, 1902. Paper read before the Association of Municipal Tramway Managers, July 4, 1902.)—It is a mistake to instal at first very large generating sets. As an installation is extended, the size of unit should be gradually increased, and the arrangement should be such that two-thirds of the plant will supply the maximum load. To secure the full advantage of automatic stoking, automatic coal-handling plant is necessary, as the labour of filling the hoppers annually costs nearly 60 per cent. of that for hand firing. Washed coal is recommended if the weight charged for is that taken from the bunkers in the boiler-house after having been stored there for at least forty-eight hours. Filters for extracting the oil from condensed water are practically useless. The simplest method is to pass the exhaust steam through a tank containing baffle plates. If the steam is exhausted at a high temperature, a large proportion of oil passes into the condenser in the form of vapour, to prevent which a fine cold-water spray should be used in the baffle tank. A table is given showing the growth of the traffic and the reduction in the works cost per unit in connection with the Sheffield Tramway System from September, 1899, to March, 1902. The first and last sets of figures are :—

Date.	No. of Units Generated.	Cost per unit.	Number of passengers carried.	Cost of power per passenger carried.
Sept. 4, 1899, to Dec. 25, 1900...	313,260	0·871d.	4,626,427	0·05d.
Sept. 29, 1901, to March 25, 1902	2,803,085	0·433d.	23,177,816	0·05d.

[For the description of the Sheffield Tramway System see Abstract No. 600 (1900).] F. B.

86. *Water-power in Ireland.* **W. Tatlow.** (Inst. Elect. Engin., Journ. 31. pp. 1146–1157; Discussion, pp. 1157–1169, June, 1902.)—The author examines in great detail the various water-powers available in Ireland. In 1889 water-power to the extent of 2,147 h.p. was in use in the island—the amount is probably not greatly exceeded to-day. About 800 h.p. is in use for electric supply. Much of the power is available only in small amounts, and the author proposes "collecting" as distinguished from "distributing" systems to pick up the power from many such stations and employ it in a single factory or electrochemical works. To reduce the amount of skilled labour required, he proposes to use induction generators at the smaller power-houses. Tables are given showing the catchment areas of the principal rivers as well as the levels and areas of the lakes, and the importance of these for regulating and storing the water pointed out. The author urges the importance of the collection of systematic data as to rainfall and river levels at different times of year, and suggests that the Government might instruct the

Digitized by Google

Constabulary to take observations. In the *Discussion*, **W. F. Barrett** (Chairman), suggested that considerable power might be available in Dublin from the water supply. **M. Harriss** dwelt upon the great importance of obtaining permission to use bare overhead conductors for electrical transmission. **J. Perry** discussed the possibilities of electrical accumulators for compensating irregularities in water supply and estimated the cost of maintenance and interest on the battery at present as £10 per h.p. per annum working a ten-hours' day. The **Author** in reply, pointed out that the length of pipe-line for the Dublin water supply was so great that the head would be practically all taken up in friction unless the diameter were excessive. He also pointed out the importance of pumping water into high reservoirs as a means of storing power as proposed for Arthur's Seat in Edinburgh, and as actually practised in Zürich, where a reservoir at 475 ft. head stored 5,000 h.p.-hours and at Geneva where 4,000 h.p.-hours were stored with a head of 890 ft.

A. E. L.

87. *Protection of Long-distance Transmission Lines.* **F. A. C. Perrine.** (Electricity, N.Y. 22. pp. 301–302, June 4, 1902. Paper read before the National Electric Light Association at its 25th Convention, held at Cincinnati, Ohio, May 20–22, 1902.)—The author first briefly mentions some of the difficulties of protection peculiar to very long high-voltage transmission lines, and then discusses the best methods of protection. Local thunderstorms are of frequent occurrence during the summer months, and on account of the large stretch of country traversed by a long transmission line, the chances of disturbance are much greater than with a short line ; further, any protecting devices which are only intended to be connected up temporarily while danger is apprehended are out of the question in the case of a long line. All apparatus producing open-air arcs must be carefully avoided, since such arcs are of a rapidly oscillating character, and may actually be instrumental in raising the line potential. General atmospheric differences of potential and small induced charges may best be guarded against by a frequently earthed wire run in the neighbourhood of the line, and for this purpose the author recommends the use of the highest grade barbed wire carefully stapled to the poles. Objections have been raised against the use of such a wire, and it has been stated that the wire causes a loss of energy and increases the capacity of the line. The author asserts that exact measurements have shown no appreciable loss of energy due to the presence of the barbed wire, and the increase of capacity brought about by it is comparatively insignificant. The author further recommends the use of lightning arresters with choking coils.

A. H.

88. *High-Potential Surges in Transmission Circuits.* (Amer. Inst. Elect. Engin., Trans. 19. pp. 905–916, June–July, 1902. Discussion on Thomas's paper [see Abstract No. 1446 (1902)].)—**F. O. Blackwell** stated that in making a high-potential circuit, a discharge occurs over lightning arresters which does not take place in interrupting the circuit. The use of much reactance in series with a transmission line to force lightning into a discharge path might produce serious results ; this is very marked with Y-connected three-phase transformers on transmission lines of high capacity. In one case, on connecting such an arrangement of transformers to an open-circuited 80,000-volt line 70 miles long, an arc jumped across transformer terminals a foot or more apart ; in spite of this, the insulation in the transformer (about $\frac{1}{4}$ in. thick) was not punctured—a result which shows

Digitized by Google

the ability of a good insulating material to withstand instantaneous applications of high potential. **H. W. Fisher** gave an account of his investigations on the measurement of high voltages by the length of spark distances between points. It is generally found that the sparking distance curve for e.m.f.'s up to 10,000 or 15,000 volts is practically a straight line above 8,000 volts, but becomes curved for lower voltages; this effect seems to be due to the bluntness of the points. By means of electrolytic methods, metallic points were prepared which still remained sharp under a magnifying power of 600 diameters, and it was found that the sparking distance curve for e.m.f.'s below 8,000 volts approached a straight line passing through the origin the more nearly the sharper the points used. Hence it is important to use very sharp points. With 6,000 volts it was found possible to increase the spark distance as much as 25 per cent. by filing a very little off the point. Another cause of inaccurate results is to be found in the brush discharges taking place in an outward direction from the electrodes; an attempt to check the irregularities due to this cause by fitting the electrodes with metallic discs set slightly behind the points proved successful. **C. P. Steinmetz** described experiments carried out by him on a transmission line 44 miles long, having a resistance of 140 ohms, an inductive reactance at 60 cycles of 220 ohms, and a capacity reactance of 6,000 ohms. The voltage used in the experiments was 40,000. The primary object of the investigation was to determine the behaviour of various types of switches, and the nature of the electrostatic disturbances produced in a circuit of high capacity by rupturing it under heavy inductive load. By means of the oil switch, the circuit could be opened without any dangerous rises of potential. An air switch fitted within an enclosing tube sometimes failed to break the circuit, and when this happened rises of p.d. up to 150,000 volts, or over twice the normal p.d., were observed. Attempts to open the circuit by using an open-air switch, consisting of two metal rods 5 ft. in length, separated by 10 in. at the lower end and receding from each other to a distance of 6 ft. at the upper end, always failed at 40,000 volts and heavily inductive load; the arc in this case flared up and stretched out to a length of some 35 ft. Experiments on the disturbances set up at the instant of connecting the generator to the line while open at the receiving end showed very large rises of p.d. (up to 125,000 volts); the most dangerous oscillations are not the very localised oscillations of very high frequency, but oscillations of relatively low frequency (approaching that of the circuit) extending over the whole or a large part of the system; such oscillations cannot be guarded against by the use of reactance coils (since these would also throttle the main current), and they may extend over the whole system through transformers and into generators. **B. A. Behrend** constructed a number of curves showing the potential gradient over a cable at different times and at different points of the cable when one end of it is suddenly raised to a high potential. A. H.

89. *High-tension Continuous-current Systems.* **A. S. Barnard.** (Electrician, 49. pp. 440–442, July 4; Discussion, pp. 512–514, July 18, 1902. Paper read before the Incorporated Municipal Electrical Association.)—The author discusses the use of high-tension continuous-current systems with substations as employed at Hull and elsewhere. He claims that the continuous-current generators are cheaper than three-phase generators, and that the transformers are cheaper than three-phase to continuous-current motor-generators. His experience of 510-kw. 2,250-volt dynamos at Hull led him to think that these

Digitized by Google

are by no means the limits either of output or voltage. He gives efficiency tests of feeders and transformers, and describes the arrangements for actuating the switchgear from the central station. *Discussion.*—**J. F. C. Snell** questioned the relative prices for alternate and continuous-current plant given in the paper. He discussed the details of the works costs at Hull, and asked for an explanation of the establishment of separate stations for the lighting and the tramways. **S. Z. de Ferranti** called attention to the early work of Marcel Deprez and of Thury on the Continent in the use of continuous currents at extra high pressures. Personally he saw no reason for using continuous current rather than alternating. **C. H. Wordingham** believed that continuous-current transformer systems would never come into very general use, as the highest pressure practicable was probably about 3,000 volts, while with alternating currents 6,000 or 10,000 could be employed. He did not see the necessity for actuating the switchgear from the central station, since the Board of Trade required the presence of a skilled attendant at the high-pressure substations with running machinery unless very small.

A. E. L.

90. *Effects of Self-induction and Capacity in Transmission Lines.* **G. H. Baillie.** (Electrician, 49. pp. 517–519, July 18, and pp. 635–638, Aug. 8, 1902.)—Simplified formulæ for the self-inductance and capacity of single and polyphase transmission lines suitable for practical engineering work are given. Useful diagrams are drawn to show the drop due to self-induction in overhead lines and concentric cables and the saving in power due to the capacity of the latter when the power-factor of the load is 0·7. To calculate the watts lost in a long transmission line the following formula is given :—

$$W = 2R\left\{C^2 + (C\tan\phi - \tfrac{1}{2}C')^2 + \tfrac{1}{4}C'^2\right\}$$

where R is the resistance of each line, C is the "watt" current, C′ is the "charging" current, and cos ϕ is the power-factor at the far end of the line. In calculating C′ it is best to assume that the charging pressure for the condenser is the pressure at the far end of the line plus one-third of the drop. The St. Croix three-phase power-transmission line at Wisconsin is taken to illustrate the formulæ given. The line consists of two three-core cables in parallel, one of the cables being rubber and the other paper insulated. The working pressure is 25,000 volts and the lengths of the cables are about 27 miles. The power transmitted is 3,000 kw. giving a watt current per wire of about 34·6 amperes. The charging current is 29 amperes for the paper cable and about 58 amperes for the rubber cable. The ratio of charging to watt current is 0·84 for the paper cable and 1·67 for the rubber cable. The saving due to the capacity of the paper cable with a power-factor of 0·7 is 30 per cent, or 100 kw.; with a p.f. of 0·8 the saving would be 25 per cent.; and with a p.f. of 0·9, 14 per cent. The author shows that by taking capacity into account the sections of the copper of the three cores of the cable with the paper insulation could be reduced by 28·5, 24, and 13·3 per cent. respectively for power-factors of 0·7, 0·8, and 0·9. A. R.

91. *Two-* versus *Three-wire Distribution.* **J. F. C. Snell.** (Elect. Engin. 30. pp. 120–122; Discussion, pp. 122–124, July 25, 1902.)—The advantages of the three-wire system are (1) Economy in copper; (2) increased radius of supply; (3) smaller percentage variation of pressure on the lamp and motor

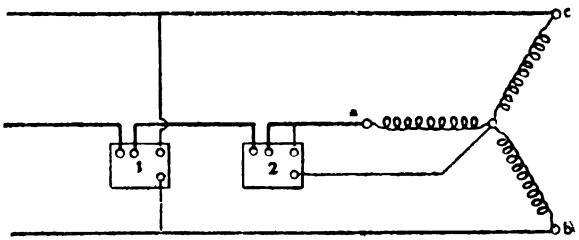
Digitized by Google

circuits. The disadvantages are (1) Difficulty of balancing, which increases as lamp density rises, and consequent variation of pressure; (2) the middle wire is, in practice, larger than the theoretical size required; (3) switchboard complications; (4) less reliability of supply as compared with two-wire; (5) the burning out of consumers' lamps on a temporary or permanent short-circuit occurring between the middle and outer conductors; (6) the effects of electrolysis and osmosis on the negative cables; (7) the electrolytic action on pipes due to leakage currents; (8) difficulty in localising and rectifying faults on the middle wire without interfering with local consumers' supply. The author cites authorities in support of his arguments as to leakage due to the compulsory earthing of the middle wire, and the bad effect of this on the negative conductors. A 400 volt three-wire system is reckoned economical over an area radiating 2½ miles from the generating station, which would cover most provincial towns. But, when the lamp density shall have increased to about twenty times present values, the size and cost of feeders to maintain equable pressure throughout the system would be prohibitive. As to cost, a two-wire distributor consisting of two 0·2 sq. in. conductors costs £78 per 100 yards fixed; and a three-wire distributor of 0·1, 0·06, and 0·1 sq. in. costs £72, or only 8 per cent. less. The percentage voltage and energy loss in the former is double that in the latter. In a network covering 25 miles of frontage the relative costs are £34,820 and £31,680—a difference of £2,640 assuming an annual output of 7,000,000 units. The losses would be 156,816 and 78,408 units respectively—a difference of 78,408 units in favour of the three-wire. The cost of feeders is given as £21,000 and £26,000 respectively—a difference of £5,000 in favour of the three-wire system. The energy losses would be 385,580 and 199,400 respectively—a saving of 186,180 units annually on the three-wire system. At ¾d. per unit generated the cost of increased loss on the two-wire system is £660 per annum. The total extra cost of feeders and distributors is £7,640, which at 6 per cent. equals £458, making a total debit against the two-wire system of £1,118 annually on a system having an estimated capital outlay of £350,000 and with a minimum revenue of £50,000. The author is of opinion that the disadvantages enumerated far outweigh this consideration. *Discussion.*—**E. T. Ruthven Murray** disagreed with most of the author's conclusions. With a three-core or triple concentric conductor the last four objections named by the author disappear. The author's numerical example was an unfair comparison, as it assumed half the percentage drop in the three-wire case, and the ostensible strength of the paper was in the numerical examples. **F. A. Newington** disagreed with the argument as to difficulty in balancing and switchboard complications. He had found no leakage on the middle wire. He agreed with the last speaker as to the unfairness of the numerical comparison. **R. A. Chattock** said there were no troubles due to electrolysis on the three-wire system at Bradford. The cost of a three-wire switchboard was very little more than that for a two-wire one. **J. N. Schoolbred** agreed that the life of cables on the simpler system must be longer. **J. S. Highfield** believed that the two-wire system was cheaper and simpler than the three-wire. **V. A. H. McCowen** and **W. H. Tittensor** queried the author's figures as to efficiency. **H. Boot** thought the cable troubles were largely due to overloading. **A. P. Trotter** was of opinion that three-phase substations were a little bit overdone. **H. F. Proctor** said that on a three-wire alternating system the balancing difficulty was got over by having the transformers diagonally wound. The **Author** in reply, held that the actual saving in copper on a three-wire system is only 40 per cent. as

Digitized by Google

compared with two-wire, and that the balancing difficulty increased with the increase in lamp density. As to electrolysis, he knew of two towns where water engineers had found differences of potential of 8 to 10 volts in their pipes, which must lead to decomposition. F. B.

92. *Measurement of Power-factor in Balanced Three-phase System.* **B. Frankenfield.** (Elect. World and Engineer, 40. pp. 245–246, Aug. 16, 1902.)—The author uses two wattmeters, 1 and 2, connected as shown in the



accompanying sketch. If w_1, w_2 be the readings of the wattmeters, and $\theta =$ angle of lag, then it may be shown that $\tan\theta = w_1/\sqrt{3}.w_2$. One wattmeter might be used to take the two readings in succession. A. H.

93. *Earthing.* **H. Faraday Proctor.** (Elect. Engin. 30. pp. 92–93; Discussion, pp. 93–95, July 18, 1902.)—(1) On a two-wire installation, connected to a supply system, if one conductor be wholly uninsulated, neither switch nor fuse should be inserted therein at any point. If the uninsulated conductor become severed at any place there would be a risk of earth currents, and the resulting electrolytic troubles. If the distributing system be earthed at one point only, it would not be permissible to connect installations with one uninsulated conductor. The author suggests the use of a number of earth-plates well distributed over the system. (2) On a three-wire installation with wholly uninsulated neutral the above conditions apply, and it is permissible and advisable to connect installations having one conductor uninsulated. No switches nor fuses to be inserted in the uninsulated conductor. (3*a*) When a two-wire installation is connected to a supply system having one conductor earthed at one point only, such installation should have fuses on the supply as well as on the lamp side. A numerical example is given to show the value of the earth current under given conditions. (3*b*) The same argument holds in the case of a two-wire installation connected to one side of a three-wire system with neutral earthed at one point. (3*c*) In an installation carried out partially or wholly on the three-wire system it is desirable to insert fuses in the neutral conductor. If the amount of three-wire work be very small, *e.g.*, a neutral between the supply mains and a distribution board only, fuses should not be inserted in the neutral till it is split up into two two-wire systems. (4) Although not intentionally earthed, a neutral should be treated as though it actually were earthed. (4*a*) On two-wire installations fuses should therefore be used on both conductors. (4*b*) Same as 3*c*. Where the whole of the work is on the three-wire system fuses should be inserted in each conductor. *Discussion.*—**Mr. Raphael** was of opinion that the use of fuses on the earthed middle wire would greatly increase the fire risk. **Mr. Highfield** thought it safer to earth the middle wire at one point only. On the general question of earthing he preferred the permanent

Digitized by Google

earthing of the negative main, as in tramway systems. He questioned the author's statement as to the absence of electrolysis on an alternating system. **F. A. Newington** agreed with the last speaker. **V. A. H. McCowen** said it was easier to locate faults when the neutral was earthed at the generating station only. He objected to carrying the middle wire beyond the consumers' terminals. **A. P. Trotter** thought it was a great waste of material to insulate the middle conductor throughout its length, as well as the outers. He saw no difficulty in taking the three-wire system into consumers' houses, but the insurance companies had objections to it. He referred to his experiments on alternating-current electrolysis. He had proved that this did actually occur. Signs of electrolysis occurred at current densities of less than 1/40 amperes per square inch. **S. F. Walker** thought that it was better to keep earth out of the system altogether, and to improve the mechanical strength of the insulation. **W. B. Esson** said that to earth the middle conductor throughout its length would mean increasing very considerably the section of copper, but that they could not earth the houses unless the complete system were earthed. F. B.

94. *Earthing the Middle Conductor.* **A. J. Abraham.** (Elect. Rev. 51. p. 291, Aug. 22, 1902.)—The continuous record, at the generating station, of the current from the middle wire to earth gives no indication as to the insulation of the network. Various ways of earthing the middle wire are in use. In some stations the connection is made through a variable resistance and a fuse ; in others, through incandescent lamps in series ; and in others through a 50-ampere fuse, shunted with a bank of incandescent lamps, which will carry about 12 amperes when subjected to a pressure of 250 volts. When the recording ammeter is not protected by a fuse it is usually protected by an automatic short-circuiting switch, which leaves in circuit an ammeter upon which the current can be read. The recording instruments usually read from 0·1 to 5 amperes on each side of zero. A diagram is given of Elliott Bros.' arrangement, whereby the recorder, by means of an automatic shunting device, will record any desired current up to 500 amperes.

G. Hooghwinkel (Elect. Rev. 51. pp. 336–337, Aug. 29, 1902.)—Three-wire distributing systems with uninsulated neutral are quite common in Germany, and not objected to by the postal or telephone authorities. The cross-section of the neutral is, in England, usually equal to half that of the outers, whilst on the Continent the practice is to make it only one-quarter. The permissible loss on the neutral is 3 volts, if few arc lamps are in circuit ; otherwise only 1 volt loss is allowed. The author recommends the connection of the middle wire and the armour of the outer cable at intervals of about 50 yards by means of copper section wires. By the use of an uninsulated neutral the author argues that most of the existing difficulties would be overcome.

E. Morgan. (Elect. Rev. 51. p. 388, Aug. 29, 1902.)—The writer is of opinion that less difficulty would be experienced with an uninsulated neutral than under existing conditions. F. B.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

95. *The Edison Company's Station, Boston.* **I. E. Moultrop** and **R. E. Curtis.** (Amer. Soc. Mech. Engin., Trans. 23. No. 942, pp. 569–590 ; Discussion, pp. 590–593, 1902. Paper read at the Boston meeting, May, 1902.)—This station in the Atlantic Avenue has already been noticed in Abstract

Digitized by Google

No. 2080 (1902). The authors here deal with general considerations in connection with the design. The main points insisted upon were the necessity of having the switchboards in a central position, and the importance of arranging the station in such a way that no conceivable accident could necessitate the entire suspension of operations even for a moment. The switchboards are arranged in two halves, on balconies facing each other, the whole being separated from the rest of the station by substantial brick walls, terminating several feet above the roof. The switchboard rooms are on two floors, and will be extended upwards; the floors are of slate on steel framework. The machines are connected to motor-worked switches, carrying up to 7,000 amperes, mounted on cast-iron posts, one series of posts being for positive and one for negative switches. The motors are mounted on the tops of the posts, and the switches are controlled by selector switches on the operating table. The steam pipes were originally arranged on the ring system with a plentiful supply of valves, but this arrangement has been abandoned, and each engine is now connected to certain boilers, and can, if needed, be also connected to those in the immediate neighbourhood. Diagrammatic plans of the steam piping are given. The distributing pipes are now 12 in. in diameter, and are limited to 50 ft. in length, being anchored near the middle of each length. Sliding bearings are preferred to roller bearings, as eliminating vibration. Neither copper pipes nor screwed flanges are used; the steel flanges are welded on. Joints are tongued and grooved, and made up with thin corrugated copper gaskets. All valves controlling branches from the boilers have auxiliary valve stems, which are taken through brick walls to points where they can be safely worked under any conditions. The condensers are at some distance from the engines; the main portion of the exhaust pipe is made of riveted steel plates, and is 50 in. in diameter, all seams being caulked inside and outside, and all joints butted with outside straps. The construction and details are fully described. Superheating is used, and its application will be extended. The amount of superheat at present varies with the position of the engine, from 100° F. at the throttle valve downwards. A notable economy of coal is considered to result from superheating, and figures are given showing results obtained. The coal-handling plant consists essentially of a steel pocket, running the full length of the wharf, with storage space in the rear; three unloading towers traversing the top of the steel pocket; bunkers in the boiler-house, supported by the roof trusses; and an elevated cable railway, travelling over all the above, with self-dumping cars of 2½ tons' capacity. Some of the larger exhaust valves are being worked by motors, which are controlled from distant points, and it is regarded as certain that all valves of more than 24 in. diameter will soon be so worked. W. H. S.

96. *Ottawa Electric Lighting Scheme.* **A. A. Dion.** (Elect. World and Engineer, 39. pp. 989–995, June 7, 1902.)—This article describes the reconstructed supply stations and new plant necessitated by the fire which devastated the adjoining cities of Ottawa and Hull, Canada, in 1900. Power is derived from the Chandière Falls, which give an ample supply of water at a head of 40 ft. all the year round; but as a stand-by steam plant has also been erected in an auxiliary station situated alongside of the Ottawa River. It is not anticipated, however, that it will be necessary to operate this auxiliary plant to any extent until the load has increased sufficiently to warrant its use. This "steam" station and one of five hydraulic-power stations are the only buildings which survived the fire. The latter is now

Digitized by Google

used also as an auxiliary to a new central hydraulic station which has been erected. The main part of the distribution is two-phase alternating, three Westinghouse generators of 700 kw. capacity being at present installed in the central station and two generators of the same capacity in the hydraulic auxiliary station. Part of the supply at the central station is distributed to a 300-kw. rotary converter, which provides current for a direct-current motor service on a three-wire 500/250-volt distribution. It was necessary to provide this direct-current service for motors already installed by customers and for direct-connected elevators, but all other power service is being done by two-phase alternating currents, so far, entirely separate from the lighting service. The city arc lighting is supplied by six two-circuit generators, each having a capacity of 150 enclosed lamps. These generators are driven in pairs by 250-h.p. two-phase induction motors. The auxiliary steam station contains a pair of two-phase generators of 250-kw. capacity, and a direct-current 500-volt multipolar machine of 500-kw. capacity. This last is used in case of break-down of the direct-current plant in the central station. The current generated in both the auxiliary stations is transmitted to the central station. The two-phase generators in the central and auxiliary hydraulic stations supply current at 2,300 volts and 60 cycles, those in the former being 40-pole machines of the revolving armature type, running at a speed of 180 r.p.m., and those in the latter 22-pole machines, having a speed of 327 r.p.m. The whole of the distribution is by overhead lines covering the cities of Ottawa and Hull thoroughly. The present installation includes 99,000 incandescent lamps, 670 direct-current arcs, 175 motors, besides fan motors, heaters, and other appliances. The article, which contains a detailed description of the buildings and plant, is fully illustrated, and a map of the distribution area is shown. J. G.

97. *Cauveri Falls Power Transmission.* (Engineer, 93. pp. 553–556, June 6, and pp. 576–579, June 13, 1902.)—The scheme consists in utilising a part of the great natural power running to waste at the Cauveri Falls, and applying the power to driving the mining machinery, stamps, crushers, air-compressors, pumps, &c., used throughout the Kolar goldfields, situated at nearly 100 miles distance from the Falls. Neither of the two falls has a vertical drop of more than 140 ft.; but the river-bed for a couple of miles above and below the falls has a very considerable drop. It was decided to take advantage of this fact, and to draw the water from a point 1½ miles above the falls, whence it is conveyed by service channels to a site favourably situated for a generating station. This gives a clear fall of over 400 ft. In order to generate the required horse-power, namely 6,250, at the wheels, the hydraulic contractors demanded 190 cu.ft. per second for their turbines. It was therefore decided to construct two channels, each capable of delivering 250 cu.ft. per second. *Generating Plant.*—The power is used almost entirely for operating induction motors, and, owing to the length of the line, and to the fact of practically no lighting power being required, a frequency of 25 cycles was adopted. The line voltage is 30,000. Six 2,200-volt generators have been provided, of 750 kw. each. Five only will be required to deliver 4,000 h.p. at the receiving end of the line, the remaining one being spare. The generators are of the G.E. standard type, with revolving fields and stationary armatures. The high-voltage winding is stationary, and subject to no strain due to centrifugal force or vibration. The revolving part contains no winding which has a difference of potential of more than 60 volts; this low voltage for excitation permits the use of strip copper winding on the fields, which

Digitized by Google

has the advantage of securing the most perfect mechanical structure. One edge of each turn of the field winding is exposed and air is forced through the core and winding of the armature by the revolving poles. The speed is 300 r.p.m. The two exciters, of 75 kw. each, are of the multipolar type, with carbon brushes direct-connected to special turbines. They are wound for 110 volts and compounded. The speed is 465 r.p.m. Each exciter is capable of furnishing sufficient current for the excitation of the whole six of the generators, and also for the auxiliary lighting of the generating and transforming stations. Twelve step-up air-blast transformers of 400 kw. each are provided; nine of the transformers will be required to transform the current of five 750-kw. generators, and three serve as spares. The transformers are arranged in groups of three, each group controlled on the low-pressure side by a triple-pole oil switch, and on the high-pressure side by three single-pole double-break 40,000-volt oil switches, one for each phase.

G. W. DE T.

98. *Concord, N.H. Water-power Plant.* (Elect. World and Engineer, 40. pp. 45-47, July 12, 1902.)—This plant was first installed in 1892 in a water-power station situated at Sewall's Falls on the Merrimac River about four miles from the town of Concord. Across the river a dam about 500 ft. long was built, enabling a fall of 16 ft. of the entire flow of the river to be used for generating power. At this station in the year above mentioned three-phase generating plant was installed, the minimum capacity of the station during the dry season being rated at 2,500 h.p. It was found necessary to employ an auxiliary steam plant to take the load during the early portion of the winter when the anchor ice became troublesome; but the period of such use is only of short duration. In 1901 the water-wheels and generators were replaced by plant of larger capacity. The new water-wheels comprise five pairs of horizontal turbines, each pair being 36 in. in diameter and rated at 300 h.p. when operating at 140 r.p.m., under a head of 15 ft. of water. The three-phase generators, which are belt-driven, are of the revolving magnet type, with a capacity of 200 kw. at 2,600 volts, and supply current at 60 cycles, the combined capacity of the generators being thus 1,000 kw. These generators supply the current for incandescent lighting and power to the village of West Concord, which is situated 2 miles from the generating station, and also to a substation at the business centre of the town of Concord about 4½ miles away. The transmission is by means of overhead wires, partly at 2,500 volts, and partly at 10,000 volts, the voltage in the latter case being raised by transformers at the generating station. The energy transmitted at 10,000 volts is partly supplied to the shops of the Boston and Maine Railway which are distant 5½ miles from the power station. At these shops two transformers, of 200-kw. capacity each, change the energy from three-phase 10,000 volts to two-phase at 440 volts. The local city circuits are supplied directly at 2,500 volts, but owing to the increasing losses in the distributing mains, the load is being gradually changed over to 10,000-volt transmission circuits. The transmission wires cross the Merrimac River by a span 700 ft. long. For the commercial local service in Concord, the 2,500-volt circuits extend generally over the city, and in the business centre, a closed loop of about 1 mile in length is run, to avoid the frequent use of small transformers. This loop is composed of three primary and three secondary wires between which transformers are connected, the p.d. between the secondaries being 110 volts. From the secondary loop, service wires are carried directly into the premises of consumers. The arc lighting of the city is supplied

Digitized by Google

at 2,500 volts from separate circuits which do not pass through the substation. The current is generated by two direct-current arc dynamos having a capacity of seventy-five 1,200-c.p. lamps, and driven by one of the old three-phase generators which is now used as a motor of 150 h.p. The auxiliary steam plant is installed at the substation, and consists of a Babcock-Wilcox boiler, rated at 600 h.p., supplying a 500-h.p. compound engine which is belted to a 450-kw., three-phase, 60-cycle, 2,500-volt generator. Tables are given showing the capacities of the various transformers, motors, and meters in use. J. G.

99. *Pike's Peak Power Transmission.* **R. M. Jones.** (Elect. World and Engineer, 40. pp. 119–123, July 26, 1902.)—This power transmission is being carried out by the Pike's Peak Power Company, of Victor, Colorado. There is an ample water supply from neighbouring mountain streams. A dam and reservoir 5½ miles from Victor is the largest steel-faced, granite-back filled dam yet constructed. It is 405 ft. in length along the cap, 220 ft. length of base, 148 ft. cross-section of base, and 20 ft. cross-section of cap. The upper slope, being the steel face, is 30° from the vertical, and the lower slope 50° from the vertical. The height of the dam from bed rock to the top of the sixteenth plate (being the spillway) is 70 ft. The spillway is 40 ft. wide, cut in granite formation, and passes around the north-west end of the dam. The granite back fill, to which the steel plate is laid, is carefully laid in "dry wall" of heavy granite boulders, usually 20 to 80 cubic ft. each, as broken by heavy blasting, with loose fine granite filling the intervening space. The steel plate is built up of sheets 5 ft. by 15 ft. and ¼ in. in thickness for the bottom eight plates in height. Continuing, the plate is reduced in thickness to ⅜ in., and finally at the cap it is ¼ in. The entire sheet is riveted with horizontal butt straps, and 4 in. by 5 in. by ½ in. angle bars are placed vertically the entire height of the dam across each interval of 15 ft. for the entire length. The 5-in. leg of each pair of angle bars projects into the reservoir, and constitutes a standing joint seam, with an iron liner ⅜ in. by 2 in. riveted between the extreme outer points of these angle bars, thus making a thorough expansion joint for each section of 15 ft. The bottom and end connection of the entire sheet is concreted into a deep channel-way, quarried out of bed rock, and the bottom terminates in two pairs of 5 in. by 8 in. angle bars, which are riveted through the plates. The end connections are prepared in exactly the same manner, but are applied vertically. The quarrying of the bed-rock channels was carried out horizontally in each case to a point rising to an elevation, and thence the rise was made abruptly in terrace form. The entire sheet is riveted up and caulked in the same thorough manner as in boiler practice. A space of 6 in. was left between the steel plates and smooth surface of the granite back fill. This narrow space is taken up by sand, gravel, and sedimentary deposit, the filling having been applied with ample water, and permitted to dry before water pressure was allowed to enter. The reservoir has a surface area of 180 acres, and holds 102,000,000 cubic ft. of water. Water is taken into a wood stave-pipe through a "Grizzley" 240 ft. long, perforated, giving thirty times greater area than the pipe. The "Grizzley" and the main pipe line are connected to the steel facing of the dam by steel angle connections. The wood pipe is 23,200 ft. long, 30 in. inside diameter, and is of 1½-in. redwood stave banded, with ½-in. steel bands and cast-iron lugs. From a point 200 ft. below the Skaguay Tunnel, where the static pressure reaches 220 ft., the line consists of steel pipe 29 in. in diameter in various thicknesses of plates, ranging from

Digitized by Google

¼ in. to ⅜ in., as required to meet the internal pressure with an ample factor of safety. The total length of steel pipe, including the receiver, is 2,900 ft., on an incline averaging 38 per cent. The hydraulic apparatus was manufactured by the Pelton Water Wheel Company, of San Francisco. Each unit consists of two steel disc wheels 66 in. in diameter, keyed to the same shaft, and working in the same wheel-house. The base frames are built up in box fashion of the same type and general design as the generators, to which they are connected. The connection of water-wheel and generator shaft is effected by a 7,000-lb. cast-steel balance wheel, banded with a rolled-tyre steel band 4 in. in thickness. The wheel is 7 ft. in diameter, and its hub forms the connection of the water-wheel shaft, and one half of the hub forms the other half of the face coupling keyed to the armature shaft, making an accurate and rigid direct connection of the shafts of the two machines. The nozzles used with which to produce the required power, as applied under 1,160 ft. effective head obtained, require only a diameter of 1 in. for 236 h.p., including losses. They are of the deflecting type. The nozzles for each unit vary in diameter, one having the capacity of the generator, and the corresponding nozzles for the other wheel in the same unit being somewhat reduced. Each wheel in each unit will produce power for the full capacity of the generator connected. In operation, however, it is customary to install such a varied diameter or capacity of nozzles as to permit the operation of the full capacity of the load demand from time to time by the operation of nozzles under full pressure, and but slight loss in water due to regulation for low loads. The electrical generators now in operation are four 400-kw. G.E. machines three-phase 30 ∿, 600 volts, with stationary armatures and rotary fields, making 450 r.p.m. Two 4-pole, 30-kw., 70-volt exciters running at 675 r.p.m. can excite the four generators at full load. The water wheels were guaranteed to have an efficiency of 83 per cent. at full load. The generators have an efficiency of 94 per cent. at full, non-inductive load. All water connections were tested to 800 lbs. pressure per sq. in. There are six 250-kw. air-blast G.E., 600–12,600-volt transformers. Two 200-kw. compensated three-phase, 60 ∿ generators are employed for combined arc and incandescent lighting. They are 12-pole machines running at 600 r.p.m., and contain their own independent 12-pole exciters, built directly on the revolving field shafts, which are direct-connected to impulse type water wheels. The line voltage is 12,600, and the circuits consist of three No. 4 B & S power wires, and three No. 6 B & S lighting wires. These are capable of delivering 16,000 kw. at an energy loss of less than 5 per cent. The lines are transposed at intervals of half a mile. The poles also carry two No. 10 galvanised telephone wires, transposed at intervals of 120 ft. The 5½ in. insulators consist of three independent cups, and were tested to 40,000 volts. The transmission circuits enter the substation through nine 50-kw. G.E., 12,000–460-volt oil transformers for local lighting on the Y four-wire system and for local power work. There is also a set of three 50-kw. 12,000–350-volt oil transformers, operating a 120-kw. rotary converter for driving a locomotive. High-pressure distributing lines leave the substation in various directions, passing through 20,000-volt oil switches, so as to make each line independent. Two additional power stations are to be constructed, through which the water discharged from the first will pass in succession. G. W. DE T.

100. *Electrical Power at Linwood Paper Mills.* (Engineer, 94. pp. 58–59, July 18, 1902.)—This is a description of a complete electrical power installation, which has been in operation for upwards of a year at the Linwood Paper

Digitized by Google

Mills, Renfrewshire. The chief aim in introducing electric driving was to secure greater facility of speed regulation, but a considerable saving in cost of fuel and labour has also resulted. Allowing 10 per cent. for interest and depreciation on the initial outlay, and adding to this the working expenses, the cost per unit generated amounts to 0·259 pence. It is estimated that the saving in coal alone will pay off the first cost in about five years. When completed, the generating plant will consist of four combined Willans-Peebles steam-engine and dynamo sets, each of 800 kw. capacity. At present only two sets are in operation. The motor equipment consists of eight 80-b.h.p. motors, two 50-b.h.p. motors, and ten 25-b.h.p. motors. An interesting feature of the installation is the employment of a number of paper pinions, as the result of experiments made at the mills with pinions of various materials. The description of the installation is illustrated by photographs, and by a plan and sections of the building containing the generating plant. J. G.

101. *Hydro Electric Installation for a Boot Factory at Fumay Ardennes.* **C. Dufour.** (Génie Civil, 41. pp. 165–169, July 12, 1902.)—A barrage at St. Joseph on the River Meuse gives the necessary water-power, and there are two turbines each giving 200 h.p. when running at 41 revs. with a height of fall between 1 m. 40 and 2 m. 80. The three-phase generators (Brown Boveri) run at 400 revs. and are belt-driven; the voltage is 3,500 and periodicity 40 per sec. The distance transmitted is 1,600 m. There are 30 200-volt motors varying in size from 3 to 20-h.p., and 900 16-c.p. 110-volt incandescent lamps. Besides the above a steam plant is provided at the factory to make up the necessary power when the water-power gets low. E. K. S.

102. *District Supply Station at Metuchen, N.J.* (Amer. Electn. 14. pp. 309–313, July, 1902.)—A central supply station replacing five smaller stations in various towns and villages. The plant consists of two Morrin Climax vertical boilers having an evaporative capacity of 18,000 lbs. of water per hour each, with an evaporative efficiency of 10½ lbs. of water per lb. of coal. The steam pressure is 125 lbs. per sq. in. at full load and 80 lbs. at light loads. There are two horizontal cross-compound engines with cylinders 24 and 44 in. in diameter, with 42-in. stroke combined with 500-kw. three-phase alternators running at 100 r.p.m. and giving current at 6,600 volts and 60 cycles. The feeders—from 4½ to 9½ miles in length—are all overhead (on glass insulators), with the exception of that to New Brunswick, which crosses a canal by triple conductor steel-armoured cable and is continued about 550 ft. beyond by three separate lead-covered cables drawn into ducts. The various substations are equipped with transformers or rotary converters according to the method of distribution already established. A. E. L.

103. *New York and Queen's Electric Light and Power Company's Plant.* (Amer. Electn. 14. pp. 371–381, Aug., 1902.)—Details are given of the old plant belonging to the three companies which are now amalgamated under the above title. One of the power stations, at Astoria, Long Island, has been enlarged, and the others abandoned. Current is generated at 2,200 volts, two-phase, transformed up to 7,500 volts three-phase, and transmitted to two substations, where it is transformed down to 2,200 volts two-phase again for distribution. The generating station contains three vertical compound condensing engines of 1,200 i.h.p. each, driving direct Stanley alterna-

Digitized by Google

tors of 750 kw. each, at 113 r.p.m., with steam at 140 lbs. per sq. in. The cylinders are 21 and 42 in. in diameter, with a stroke of 42 in. Steam is supplied by 7 water-tube boilers, fired by hand, with a chimney 190 ft. high. Each engine is provided with a Wheeler surface-condenser and Blake air-pump, and there are two Goubert feed-water heaters. Two old generating sets, of 500 and 300 kw., are still in use; there are also two engine-driven 50-kw. and one motor-driven 40-kw. exciters. A gravity lubricating system supplies oil to all the engines. Eight 200-kw. step-up transformers are provided, connected on the Scott system; the secondary voltage can be varied from 6,600 to 7,500 volts according to the load. The transmission line consists of two three-phase circuits, dividing to the substations at a point 2½ miles from the power station. The conductors are carried on glass insulators supported by cross arms on poles 100 ft. apart. Besides incandescent lighting, series enclosed alternating-current arc lamps are used, fed by constant-current transformers. A. H. A.

104. *Hamilton Electric Light and Power Plant.* **A. D. Adams.** (Elect. Rev. N.Y. 41. pp. 266–270, Aug. 30, 1902.)—This is a brief description of the installation of the Hamilton Electric Light and Cataract Power Company, Limited, of Hamilton, Canada; water is derived from the Welland canal, and is conducted 5 miles in an open aqueduct, followed by a steel penstock 1,000 ft. long and 8 ft. in diameter, to the power station close to Lake Ontario. There are four turbines, two of 3,000 h.p. and two of 1,500 h.p. each, working under a head of 263 ft., and driving direct three-phase Stanley alternators of 2,000 and 1,000 kw. respectively, at 2,400 volts, 66⅔ cycles per second. The pressure is raised in ten 400-kw. and ten 200-kw. transformers to 22,500 volts. There are two transmission lines, 35 and 37 miles in length, following entirely different routes to the same substation in Hamilton. One line consists of three wires carried on glass insulators in one plane, the other of three wires on porcelain insulators at the corners of an equilateral triangle of 2 ft. side; all the conductors are of copper. The substation contains step-down transformers of an aggregate capacity of 6,000 kw., reducing the pressure to 2,400 volts two-phase, for general light and power supply; there are also three rotary converters of 300 kw. each for traction, with a storage battery, and a 200-kw. motor generator for supplying power to small motors at 220 volts, direct current, the last being provided also with a steam engine as standby. The company possesses also two steam power stations in Hamilton, of 600 and 400 kw. capacity. An auxiliary steam-power plant of 2,000 kw. is to be put down near the substation. The system includes further transmissions of 7 and 11 miles from Hamilton, 54 miles of single tramway track, nearly 1,000 arc lamps and 55,000 16-c.p. glow lamps, and 380 motors aggregating 5,700 h.p., mostly of the two-phase induction type. The present maximum load is 4,800 kw., of which 1,800 kw. is for stationary motors. The nominal price for lighting is 7½d. per unit, and for power from 3d. to ¼d. A. H. A.

105. *Bogota Electric Light and Power Plant.* **F. C. Perkins.** (Electricity, N.Y. 23. pp. 87–89, Aug. 20, 1902.)—This water-power installation is 8,300 ft. above sea-level, and was constructed under great difficulties of transport, the heaviest parts of the machines being limited to 330 lbs., as for part of the journey, over mountain passes up to an elevation of 9,075 ft., the loads had to be carried by mules. The water is obtained from the Rio Funza, and is led to the power station through a masonry canal and a 6-ft. iron pipe, each 436 yds. long, with an available head of 147·6 ft. There are twelve generating

Digitized by Google

sets, each consisting of a 450-h.p. turbine by Escher, Wyss & Co., coupled to an Oerlikon three-phase alternator. The generators are of the inductor type and run at 600 r.p.m., giving 60 cycles per second. They were built in small portions on account of the difficulties of transport. The speed is regulated by an auxiliary motor automatically controlling all the turbines. Power is generated at 6,700 volts and transmitted over copper conductors 15½ miles to Bogota. The pressure is reduced in a substation to 1,600 volts, and the current is distributed to other substations in the town, where a further transformation to 160 volts takes place. Power is supplied to a large number of motors and to 2,000 glow lamps, as well as a number of arc lamps. A. H. A.

106. *Romanshorn Power Station, Switzerland.* **F. C. Perkins.** (Elect. Rev. N.Y. 41. pp. 172–173, Aug. 9, 1902.)—This is a three-phase power station, driven by gas engines, the length of the transmission line being about 5 miles. W. H. S.

107. *Baltimore, Md., Street Railway Power-house.* (Street Rly. Rev. 12. pp. 331–337, June, 1902.)—The paper describes extensions of the power-houses consequent upon increase of traffic beyond the capacity of the old stations. The system comprises 360 miles of track. In the central power-house three-phase alternating-current machinery for the outlying districts, and continuous-current machinery for the nearer districts, is being erected. Current is generated at 13,000 volts, 25 cycles, and transformed in substations to 345 volts alternating, and then to continuous current at 575 volts, at which pressure it is fed direct to the line. The two types of machinery are kept distinct—that is, in separate portions of the power-house. The alternating side is large enough for six 2,000-kw. sets, four being erected at present. The engines are of the vertical cross-compound type by the McIntosh and Seymour Company, designed to develope with steam at 165 lbs., condensing 2,970 i.h.p. at 0·26 cut-off, and 4,220 i.h.p. at 0·5 cut-off, when running at 94 r.p.m. The cylinders are 33 in. by 68 in. with 56-in. stroke. The shaft diameter is 28 in., constructed of fluid compressed hollow open-hearth steel forgings. The maximum angular variation from the mean angular velocity when running on constant load will not exceed $\frac{1}{7\frac{1}{2}}$ of the pitch angle between two consecutive poles, of which there are 32. The bearings have automatic forced lubrication. The generators are of the Westinghouse standard type, with revolving field separately excited. The output is 89 amperes per terminal at 13,000 volts and 100 per cent. power-factor. After 24 hours' run at full load the temperature rise shall not exceed 35° above the surrounding atmosphere. Two feeders are laid to each substation consisting of three-core paper-insulated and lead-covered cable, the thickness of insulation between the conductors and the lead sheath being 14/32 in. The continuous-current machinery includes three 1,800-kw. and two 800-kw. coupled sets, and three 500-kw. belted sets, the engines being 29 in. and 60 in. by 56 in. vertical cross-compound, 24 in. and 42 in. by 46 in. horizontal tandem compound, and 20 in. by 36 in. by 36 in. tandem compound respectively. The continuous-current switchboard is arranged in three tiers, viz., the generator gallery, the feeder gallery, and the resistance gallery; but for safety only one pole is brought to the board, the bus-bar for the other pole being 30 ft. away in a sub-basement. Each machine circuit is provided with two circuit-breakers, one being fixed on the board and the other near its machine. The switchboard attendant can, by means of pushes, open the circuit-breakers, which are placed near the machines. In the boiler-room

Digitized by Google

there is space for sixteen batteries of two boilers, each of the Babcock-Wilcox type, arranged in two tiers. One steel plate self-supporting chimney stack is provided for each set of four batteries; the height of each chimney is 200 ft. by 13½ ft. inside diameter, lined throughout with brick. [See also Abstract No. 416 (1902).] F. B.

108. *New Orleans and Carollton Railroad.* (Street Rly. Rev. 12. pp. 379–388, July, 1902.)—A full description is given of this railroad, comprising 84 miles of track, the construction of which was dealt with in Abstract No. 293 (1901). The track is laid on "neutral ground" in the centre of the street. Centre-pole double-bracket overhead construction is used, with iron poles; the trolley wire, of No. 00 gauge, is supported by flexible suspension. The cars are of the four-wheel closed type, seating 28 passengers each, and lighted with 15 lamps of 16 c.p. There are 120 cars, of which 70 are fitted with two G.E.-1,000 motors each, the remainder being single-motor cars. A special type of repair waggon is used, which enables work to be carried on without interfering with the running of the cars; another interesting device is a hose bridge, to carry the cars over fire hose when this is stretched across the track. An elaborate system of inspection is in force, each working part being inspected after the completion of a certain mileage; special devices are used for rapidly handling armatures, wheels, &c. There are four power stations, of which two only are used for traction; oil has recently been substituted for coal as fuel at these stations, whereby a material saving has been effected (see Street Rly. Rev. 12. p. 322, May, 1902). No. 1 station contains four 350-h.p. tandem compound condensing engines, with cylinders 16- and 32-in. by 48-in. stroke, driving by belt 200-kw. D.C. generators at 72 r.p.m.; these are supplied with steam by six water-tube boilers. No. 2 station contains two 450-h.p. engines of similar type, with cylinders 16- and 32-in. by 42-in. stroke, coupled to 300-kw. generators running at 100 r.p.m.; and one 1,275-h.p. engine, with cylinders 26- and 50-in. by 48-in. stroke, running at 80 r.p.m., and coupled to an 850-kw. generator. Here, also, there are four water-tube boilers. The feed-water is pumped by means of compressed air. Numerous illustrations are given in the article. A. H. A.

109. *Dublin Electric Tramways.* (Tram. Rly. World, 12. pp. 158–166, July, 1902.)—The paper deals with the history of tramway development in Dublin down to the present time. The electric system in use is described in detail [see Abstracts Nos. 1950 (1900) and 578 (1901)]. The operating cost per kw.-hour is 51 per cent. of that at the time of opening. In the half-year ending December 31, 1901, 23,816,084 passengers were carried, or 129,380 per day. The earnings were £128,416, the average fare per passenger being 1·28d. F. B.

110. *Chatham and District Tramways.* (Electrician, 49. pp. 427–431, July 4, 1902.)—The system is owned by the Chatham and District Light Railways Company, and comprises about 8½ miles of tramways. The car sheds, to accommodate 50 cars, are laid out in two bays, each 38 ft. 10 in. by 196 ft. 6 in. The steam-generating plant consists of four Lancashire boilers, each 30 ft. by 7 ft., designed to evaporate 5,900 lbs. of water per hour each, at a working pressure of 140 lbs. per sq. in., with mechanical stoking. The capacity of the feed-pumps is 4,800 gallons per hour, against 185-lbs. pressure per sq. in. Surface-condensing plant and a cooling pond with 50 simplex spraying nozzles are provided. All steam piping is of heavy lap-welded steel pipe, with cast-

Digitized by Google

steel flanges, tested hydraulically to 500 lbs. per sq. in. The exhaust piping is of lap-welded wrought-iron pipe, with cast-iron flanges. There are three main engines of the horizontal compound type, made by Messrs. Yates and Thom, each capable of developing normally 320 i.h.p. at 100 r.p.m., with steam at 150 lbs. per sq. in., and will stand overloading 50 per cent. The cylinders are 15 in. and 29 in. by 36 in., steam-jacketed, and fitted with Corliss valves. The crank-shaft is of open-hearth steel, 16¼ in. in diameter, with journals 14 in. by 22 in. running in Babbitted bearings. The crank-pin is 6¾ in. by 8 in. The flywheel is 15 ft. diameter, and weighs 20 tons. The operation of the valve-gear is described fully. The dynamos, which are directly coupled to the engines described above, are of the B.T.H.-standard railway type, having a normal full-load output of 200 kw. at 500 volts when running at 100 r.p.m. A negative booster is employed for the track. This is series-wound, and has an output of 17½ kw. at 50 volts. It is coupled directly to a 500-volt shunt-wound motor, and runs at 700 r.p.m. No positive booster nor battery is employed. The switchboard is of the B.T.H. standard pattern, and is built up of enamelled slate panels 2 in. thick on an iron frame. Along the whole route double overhead equipment has been carried out, the trolley wire consisting of 00 B & S hard-drawn copper. The bracket arms vary from 8 to 18 ft. in length. The feeders are laid, where practicable, under the footways, and are of the lead-covered paper insulated type, laid in wood troughing filled up with compound. The sizes of feeders are given, and a map of the district showing the feeding-points. The track is laid to a 3 ft. 6 in. gauge, the rails being of the girder type, 6 in. deep, weighing 92½ lbs. per lineal yard. They are laid in 45-, 30-, and 36-ft. lengths, and are tied about every 9 ft. The cars are of the double-deck reversed-staircase type, mounted on Brill trucks with 6 ft. wheel base, and have each a seating capacity of 26 outside and 24 inside. Service was started with 25 cars. F. B.

111. *Yarmouth Electric Tramways.* (Elect. Engin. 30. pp. 258–268, Aug. 22, 1902.)—The system extends over 4 miles of street route, comprising in all 6 miles of track. Power is taken from the electric-lighting station, which has been enlarged for the purpose, and new generating machinery put down. The traction generators are quite distinct from the lighting plant and consist of two 200-kw. Allen-Schuckert combination sets, each designed for an output of 364 amperes at 500 to 560 volts compound, and 460 to 500 volts shunt, when running at a speed of 350 r.p.m. A single-pole change-over switch fixed on the magnet frame permits of the changing of a machine from shunt to compound. A reversible booster in the battery circuit effects automatically the charging and discharging as required. The booster consists of ordinary shunt-wound motor, coupled across the main bus-bars, driving a differentially wound generator. The latter has two field circuits, viz., the ordinary shunt and a special series winding which carries a definite proportion of the main-station current. When the external load is equal to the normal full load of the generators, the series winding neutralises the shunt and the machine is inoperative. When, however, the external load is greater than the above, the series winding predominates, and the booster voltage is added to that of the batteries, causing them to discharge. When the load is below the normal generator output, the reverse takes place. The point of reversal can be adjusted by means of a variable resistance in the series circuit. The battery has a capacity of 360 ampere-hours at 45-ampere rate, and is capable of a momentary rate of 280 amperes. The tram rails are of the steel girder type weighing 90 lbs. per yard. They are 7 in. deep, with a

Digitized by Google

1⅛-in. groove, and are laid to a gauge of 3 ft. 6 in. on a bed of concrete 7 ft. 4 in. wide. Part of the track is filled in with granite sets which extend to a distance of 2 ft. 2 in. each side of the rails, making a total width of paving of 7 ft. 2 in. In other portions, lava basalt, asphalt cubes, and Jarrah wood blocks are used. Tie-bars are fixed at distances of 7 ft. 6 in., and each joint is bonded with a flexible crown bond and plastic bonds. The car equipment consists of 14 double-deck cars, each accommodating 49 passengers—22 inside and 27 out. They measure 16 ft. over the body, 26 ft. 6 in. over the platform, and have a 6-ft. wheel base. The platforms overhang 5 ft. 3 in. and are fitted with collapsible gates, and reverse stairs, sand and gong pedals, and a trap-door for access to the drawbar pin. The article is well illustrated. F. B.

112. *Electrical Equipment of Chicago Railway Clearing Yards.* (West. Electn. 31. pp. 133–135, Aug. 30, 1902.)—The clearing yards comprise a total length of 105 miles of track, sufficient for handling from 5,000 to 8,000 cars daily. The electrical power station is equipped with two 150-kw. three-phase alternators coupled to horizontal tandem compound engines, and generating at 2,300 volts 60 cycles per second when running at 225 r.p.m. Electricity is used for indoor and outdoor lighting, and for working the switches, of which there are 450; 120 of the latter are operated by pneumatic cylinders, controlled electrically from a central switch tower. The switching gear is provided with indicators to show whether the points are clear or otherwise, and 400 of the switches are electrically lighted. The arc lamps are fed with alternating current. A small motor generator and storage battery provide direct current for operating the switch-control system. A. H. A.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

113. *Central Stations for Traction.* **C. Thonet.** (Tram. Rly. World, 12. pp. 129–133, July 8, 1902.)—The author reports to the International Tramway Congress on the maintenance, consumption, and efficiency of the generating plant and accessories, and on the cost of electrical energy generated respectively by steam, gas, and water-power at various tramway power stations. A large number of miscellaneous and disconnected particulars are given relating to the plant installed. Most of the companies use economisers, condensers, cooling towers, Cornish boilers, and hand-firing. Analysis of the flue gases is recommended. The steam engines are generally of the tandem compound type, up to 1,000 h.p.; beyond that power they are usually cross-compound, to bring the dynamo between the cylinders. For very high powers triple expansion is used. The average coal consumption in ordinary working is given as 1·7 kg. per kw.-hour. Lubricants cost 0·003 to 0·1 fr. per kw.-hour. Particulars are given of a producer gas plant at Barcelona, of 630 h.p.; Crossley gas engines are used, costing with the gas plant ½ centime per kw.-hour for maintenance. The coal consumption is 1·0 kg. per kw.-hour. Lubricants cost under 0·013 fr. per kw.-hour. With coal at 36 fr. per ton, the total cost per kw.-hour is 0·08 fr. A few companies use three-phase high-pressure current, with transformers and rotary converters, but the majority generate direct current. Many companies use storage batteries in parallel with the dynamos, with or without boosters; the maintenance of the

[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

Digitized by Google

batteries costs 5 to 10 per cent. of their initial cost per annum, or 0·005 fr. per kw.-hour. The improvement in the pressure regulation due to the use of batteries is marked, and the saving in coal is estimated at 10 to 25 per cent. The cost of the Nuremberg tramways power station (1,972 kw.) was in all 1,778,000 fr., or 597 fr. per kw., a very low figure; that at Liège, a small station of 96 kw., was 875 fr. per kw. It is estimated that a fair value for a small steam station is 1,000 fr., and for a large one 700 fr. per kw. With producer-gas plant the cost would be about 700 or 800 fr. per kw. The cost of water-power stations is not stated, but is believed to be from 1,000 to 2,000 fr. per kw. The working cost, deduced from a large number of results, is stated to be, with steam, 4 to 6 centimes for large stations, 6 to 8 centimes for medium-size stations, and 8 to 10 centimes for small stations, per kw.-hour; with producer-gas the cost is 4 to 6 centimes—the cost of coal being 15 to 20 fr. per ton in each case. A. H. A.

114. *Train Resistance.* **J. A. F. Aspinall.** (Inst. Civil Engin., Proc. 147. pp. 3–41; Discussion, pp. 42–125, 1901–1902.)—In this paper the author gives the results of a series of experiments carried out on the Lancashire and Yorkshire Railway between June, 1899, and January, 1900. He endeavoured to determine accurately both the velocity and the direction of the wind during each experiment. The apparatus fixed in the dynamometer car enabled two separate diagrams to be taken—one a "distance-speed" and the other a "time-speed" chart. Most of the experiments were made with a train composed of five oil-lubricated bogie coaches and the grease-lubricated dynamometer car. The length of this was about 285 ft., which was considered to represent an average express on this line. In order to ascertain the tractive force required to haul a train at different speeds, the following procedure was adopted: The positions of the regulator and reversing gear on the engine were marked for each trial, these positions being governed by the speed at which it was desired to run. After the regulator and wheel had been set, they were left in position during the whole of the run, the engine being allowed to run at whatever speed it could, and steam pressure being kept as constant as possible. Both the outward and return journeys were made with the engine set in exactly the same position. In this way the acceleration which would have been caused by altering the position of the regulator was entirely eliminated, and, the gradients being very slight, it was possible to obtain readings at a constant speed for a mile or more. In order to verify, if possible, the results obtained with the dynamometer car, a number of "coasting" experiments were made. In these, two points were marked, one at each end of the line, the same section being chosen as that on which the dynamometer tests were made. The engine was made to start the train from behind, about a mile from the first mark point, to get up the necessary speed. Steam was then shut off, and the brake applied to the engine, which, not being coupled, was separated from the train. The speed was ascertained by counting the wheel revolutions, and the resistance was calculated from the change of kinetic energy. Experiments were also made with the engine coupled, steam being shut off and cylinder cocks opened. A number of readings with Hall anemometers were taken with a view of determining the resistance effect of the wind, both natural and created. It was found, however, difficult to obtain any definite results. To determine the starting resistance, the gradient was observed on which the train would start under various observed conditions with regard to the wind. From these it was concluded that the starting resistance was about 17 lbs. per ton, and it is so

Digitized by Google

taken in the tables and diagrams given in the paper. The formula for train resistance deduced by the author from the results of these experiments is—

$$R = 2{\cdot}5 + V^{\frac{3}{2}}/(50{\cdot}8 + 0{\cdot}0278L),$$

where R = resistance in lbs. per ton drawn; V = velocity of train in miles per hour; and L = length of train in feet over the coach bodies. The author attempts to analyse R into axle friction, atmospheric resistance, and miscellaneous resistances; the latter including oscillation, concussion, flange friction, rolling friction, &c. He finds that at a speed of 80 miles an hour, the atmospheric resistance amounts to 42 per cent., and the miscellaneous resistances to 50 per cent. of the total. The author points out that these experiments can only be taken as recording the results obtained by the particular coaches used, as variations in the wheel base of the bogies, or in the dimensions of the journals, might very possibly play an important part. In conclusion he calls attention to the careful experiments on train resistance made by officials of French railways and published from time to time. A number of formulæ for train resistance adopted by various observers are tabulated in an appendix. *Discussion.*—**A. Mallock** suggested that a considerable percentage of the miscellaneous resistances was due to what Ewing had called "hysteresis" of the ground on which the wheels ran. **H. Bell** referred to the experiments made by Desdouits with his dynamometric pendulum. He had shown that air resistance was the paramount factor at high speeds; also that the differences in the heights of the cars in a train very substantially increased the air resistance. He found that "bow and stern" plates diminished the air resistance to such an extent as to save from 10 to 20 per cent. in fuel according to the speed. He would suggest that the frictional resistance might be much reduced by driving the bogies from a point well in advance of the centre, whilst still loading them at the centre as at present. **F. Bramwell,** referring to Mallock's remarks, stated that the value of the lag, due to partial inelasticity of the rails, would be very small for the whole train. He thought the author had under-estimated the amount of the air resistance. What it was necessary to determine, if possible, was the weight of air being put in motion by the train. **S. A. Timmis** stated that, according to his own experience, the latter oscillation could be entirely eliminated by driving the bogies from a point about midway between the centre and the leading axle, thereby greatly reducing the frictional resistance. **P. V. McMahon** referred to the experiments made in 1897 on the City and South London Railway with a view to designing a locomotive to haul heavier trains at a higher speed [Proc. Inst. C. E. 139, p. 152]. The results showed that the steam locomotive had an efficiency of about 65 per cent., while tests on four electric locomotives showed an efficiency of 86 to 88 per cent., measured in a similar way, viz., as the ratio of the electrical to the useful h.p. at the draw-bar. **C. Chree** remarked on the difficulty of determining the effect of wind velocities, owing to their very rapid variation, which might be as much as from 10 to 30 miles an hour within a few seconds. Again, a train running with the wind encountered fewer air-waves than when running against it, and there was therefore less pressure variation, which explained some of the author's experimental results. Much of the importance of the Zossen-Marienfelde experiments, which A. Siemens had referred, to lay in the fact that the high velocities dealt with made the effect of fluctuations in the velocity of the wind comparatively unimportant. He considered that a continuously recording instrument should be employed for the wind observations. **F. W. Webb** called attention to the large dif-

Digitized by Google

ferences in power absorbed under apparently almost identical conditions, and suggested that this might be due to errors in connection with the dynamometer springs. With regard to the time taken for a train to come to rest when coasting, it was well known that unless very large cylinder cocks were used, when steam was shut off, there was great retarding action through the cylinders acting as air-pumps. **D. Halpin** thought the differences between the dynamometric and indicated h.p. due to the tractive resistances of the engine and tender as vehicles, and the friction of the working parts of the engine, being neglected; probably also in part to the acceleration not being accurately known. **C. A. Carus-Wilson** considered that the remarkable result that the miscellaneous resistances amounted to as much as 60 per cent. of the whole, might be largely accounted for by the steering force rendered necessary by the tendency of the bogies to assume an angular position at considerable speeds. This made the length of wheel base an important factor. The steering effort depended on the weight of the bogies rather than of the cars, so that it was an economy to have long and heavy coaches on light bogies. **R. H. Smith** considered it a pity to retain the unmeaning custom of reckoning the resistance in pounds per ton, as only a small portion of the resistance increased in that way. The **Author** did not believe in fitting prows to a locomotive, since, as Webb had pointed out in the discussion, they were actually disadvantageous on curves, or with the side winds which were nearly always present. A lead in the bogie-centre would evidently diminish oscillation. It was used in the American pony-truck, and was applied to locomotive bogies. With regard to the effect of increasing the wheel base, the practical diminution in steering effort was mainly due to the resulting increase in the oscillation period, as the flanges of the leading wheels were never long in contact with the rail. G. W. DE T.

115. *Electric Railways.* **J. Swinburne** and **W. R. Cooper.** (Inst. Elect. Engin., Journ. 31. pp. 972-1015; Discussion, pp. 1015–1057, June, 1902.)—This paper is mainly devoted to a discussion of the series system, both for short and main lines. Rapid acceleration both in starting and stopping is of the highest importance on short lines. To meet the strain of heavy traffic in the morning and evening quick service, with reduced headway between the trains, is the only way. Taking the Central London Railway as a concrete instance, a calculation is given showing the effect of running the trains half as fast again for four hours a day; the percentage of profit to capital is increased from 4·3 to 5·76. Even taking into account the extra cost of generating plant and distribution required to obtain rapid accleration and high-speed service, it will be found that it is worth while to incur this cost. On main lines high speed is of greater importance than rapid acceleration. The problem of acceleration is then considered, along with the questions of steady running and braking. The quickest point-to-point time is made when the train accelerates for half the time at the highest possible rate and retards for the other half at the same rate. The permissible rate of acceleration is limited by (1) discomfort to passengers, (2) cost, (3) slipping. As regards (1) the author takes the view that it is not acceleration but the rate of change of acceleration (d^3s/d^3t) which causes discomfort. With reference to cost, the plan of accelerating and then retarding with no interval of steady running is very expensive in energy, and not much is lost by running at top speed for about a quarter of the time. Tables are given showing the retardations and accelerations in use on various railways, both steam and electric; and a case is worked out showing the effect of varying the acceleration, retardation, and

Digitized by Google

maximum speed. The results are shown graphically by diagrams in which the co-ordinates are speed and time; the area of the curves thus represents distance. With the conditions assumed, viz., a uniform acceleration of 0·8m./sec.², continued until a speed of 88 km. per hour is attained, and an equal retardation applied immediately afterwards, and continued until the train comes to rest; a distance of 750 m. is covered in 60·8 seconds. If the acceleration is stopped at a minimum speed of 70 and the train allowed to run at this speed for about 15 seconds, the difference in time is only 1½ seconds out of a minute, or out of 70 seconds including stoppage, which may be taken at 10 seconds. The saving in energy in the latter case is, however, 37 per cent. With a maximum speed of 60 the increase in time is 4 seconds, but only 46·4 of the energy required in the first case is taken. Curves are given showing the effect of varying (1) the acceleration with a given maximum speed and (2) the maximum speed with a given acceleration, both as regards the time of the run and the power taken; in a particuar case an alteration of the conditions from 80 km. maximum speed and 0·4m./sec.² acceleration to 50 km. and 1·0m./sec.² effects a saving of 36 per cent. in time, at the expense of an increase in the power applied to the train of from 330 kw. to 1,390 kw., but by diminishing the acceleration as the speed increases, the power used may be considerably lessened without unduly increasing the time. Reference is made to the method of saving energy by having stations on gradients leading up to them, but this can only be done in the case of new lines. The only way in which a large saving of energy and power can be effected is by returning energy to the line of electric braking.

The authors then discuss briefly the various possible arrangements of constant-current and constant-pressure lines for an urban service, and calculate the efficiencies, assuming first hypothetical motors, without resistance, under similar conditions of acceleration, maximum speed, and retardation, viz., 0·8m./sec.², 70 km. per hour, and 1·0m./sec.²; and secondly, under conditions which can be realised in practice, with the acceleration in common use; and show that the series constant-current system gives the best results. Its *advantages* are summarised as follows: (1) The efficiency as regards loss of energy by controllers and return of energy to the line is high. (2) The over-all efficiency is high, because there is no transformation between the dynamos in the generating station and the motors on the train. (3) The torque is constant, and may be so maintained as long as desired. (4) The torque may be varied at will by shunting the field, or by varying the position of the brushes. (5) The control is simple, because the current is constant and need not be large; therefore the controlling gear is light and inexpensive. (6) There is a marked economy of copper under certain conditions. (7) Collection of current should be simpler than with the usual parallel systems as it is smaller. (8) High pressure in transmission is likely to be more easy to handle than by alternating current, as the dielectric is not subjected to an alternating stress, but there is no reason why higher pressures than even 22,000 volts should be used. *Disadvantages:* (1) The greatest difficulty is the necessity for careful insulation of the motors, but the difficulty could probably be overcome if the constant-current system shows enough advantages. (2) Double contacts and double conductors are of course necessary, no earth return being available. These are no doubt undesirable, but they do not form a vital objection. (3) The loss due to the resistance of the line is constant, and therefore the percentage loss increases with light load; but since traction systems seldom work light, this point is not important in the case of urban railways. In main lines, it can generally be kept low

Digitized by Google

with a little care. A table is given in *résumé* of the results obtained in the various cases; the result shows that for urban service, with the accelerations in present use, the constant-current series system takes less than a quarter of the power of the constant-pressure system with series motors.

The problem of main lines is then considered. First a table of working costs of steam railways for 1900 is given. The success of electric traction on main lines must depend largely on reduction of running costs—much more so than in the case of urban lines. Acceleration is not so important, nor the return of energy while braking; hence the parallel system would seem to have the advantage. But this is costly in distribution, and has little flexibility in point of speed, except at the cost of much waste of energy in resistances. The constant-series system is a perfect solution of the problem; as high pressures may be used, speeds may be varied without waste of energy, with maximum torque even at the highest speeds. This system also has the advantage of doing away with substations, and is simple in distribution and working. Other systems—three-phase constant pressure, three-phase constant current, transformed direct constant current, constant pressure simple alternating, and the constant pressure alternating and Leonard system—are briefly alluded to, and the possibility suggested of controlling the traffic entirely from the stations and substations, thereby doing away with the necessity for signals. In the discussion which followed **Dow** considered that the constant-current series system with electric braking might put a great strain on the generators owing to the sudden reversal of the load; the switching would also be a difficulty. The authors had left out of consideration the advantages of the storage battery for traction purposes, which deserved to be seriously taken into account, and had also omitted consideration of the recent practice of running motors in sets of four instead of sets of two. He thought that the constant-pressure system admits of much greater development than the series system, and emphasised the importance of short stops at stations and quick handling of passengers. *Discussion.*—**W. E. Langdon** thought that the steady load of main lines, as against the double peak of the load curve of suburban lines, was an argument in favour of electric traction. **W. M. Mordey** laid stress on the absence of reciprocating movement, with the consequent avoidance of the swaying of the rear of the train at high speeds, as one of the great advantages of electric driving. The constant-current series system wasted no energy in starting resistances, and effected great saving through the return of energy to the line in braking, but it was dangerous, complicated, expensive in distribution, and difficult from the point of view of extensions. He believed that the solution of the problem would be found in an alternating system. **S. P. Thompson** considered that single-phase alternating was the only possible system for railways. The difficulty was to find a single-phase motor that would start on load. Referring to the question of acceleration, he thought that some method of automatic control was preferable to leaving the matter entirely to the judgment of the driver, as in steam locomotives. **C. A. Carus-Wilson** thought that a variable speed-gear was the thing to be tried for; and to this the series-wound motor approximates, but less now than formerly, owing to changes of design intended to eliminate sparking difficulties. He considered that the range of torque per ampere should be increased; in modern motors the range is only about 30 per cent. of the smallest value, whereas a range of 100 per cent. could easily be attained by increasing the weight of the motors. **P. V. McMahon** emphasised the great cost at which rapid acceleration was secured, and was of opinion that if these high rates were used, it would be

Digitized by Google

necessary to employ some sort of variable speed-ratio gear, and also to return energy to the line when stopping the train. Nothing is to be gained by running short trains at times of light load, as the expense of shunting extra carriages would, except in the case of a multiple unit system, absorb all the saving. The constant-current series system would involve great difficulties in switching, and would severely tax the generators; and with the pressure—2,000 volts—advocated by the authors of the paper, it would not be easy to maintain the insulation. **W. Geipel** laid stress on the necessity of having a uniform system throughout the kingdom. A frequency of 40 is too high; 25 is better. For the comfort of the passengers acceleration need not be constant, but it should be varied gradually. The system should be such that the power could be taken from local supply stations. Referring to the Ward-Leonard system, it has very many advantages for railway work—perfect control, economy both in first cost and in running. As regards the extra weight, this was a positive advantage where trains are worked by locomotives, owing to the increase of tractive power. **A. A. Campbell Swinton** considered the question of uniformity to be of the utmost importance. Several railway schemes are now before the House of Lords, in which an insulated return is to be used. If that system is adopted, there will in the future be great difficulty in making the rolling stock of the Central London Railway run over those lines. **M. Holroyd-Smith** explained a method which he had devised of getting over the difficulty of an insulated return by fixing the two conductors in different horizontal planes; all fear of short-circuits at points and crossings is thus eliminated. In their reply the **Authors** pointed out that the object of their paper was to bring the constant-current system forward for discussion, but not to advocate it to the exclusion of other systems. B. P. S.

116. *Electric Traction Systems.* **W. R. Cooper.** (Inst. Civil Engin., Proc. 149. pp. 8–44, 1902.)—The paper is devoted to a general comparison of the various systems at present in use on electric tramways, and to a consideration of the possibilities of electric automobilism. The relative advantages and drawbacks of the overhead trolley, the conduit, the surface contact, and the accumulator systems are set forth and discussed. The Diatto surface-contact system is described in detail [see Abstract No. 2183 (1902)], and particulars are given of most of the accumulator traction plants at work on the Continent. The comparative costs of the different methods are examined, and supplemented by a number of curves and tables to facilitate their calculation according to varying conditions of working. E. J. W.

117. *Systems of Traction.* **E. A. Ziffer.** (Tram. Rly. World, 12. pp. 207–210, and p. 224, July 12, 1902.)—Reporting to the International Tramways Congress on the systems of electric traction in vogue, the author states that per 100 km. of track 82 are worked with overhead conductors, 7 with conduits, and 11 with accumulators. The report is confined to the two latter systems. At Brussels a tramway comprising 10 km. of double track cost 100,000 fr. per km. for the conduit alone, and 11 men are continually employed in examining the insulators, cables, &c. The working cost is for conduit lines 0·1422 fr., and for overhead lines 0·1388 fr. per car-km. At Paris the cost of the conduit per km. of single track was 188,000 fr. The Budapest conduits cost from 64,000 to 106,000 fr. per km. of single track, and the working cost is 0·2481 fr. per car-km. Particulars are also given of other conduit systems. The Schuckert, Diatto [see Abstract No. 1992 (1899)], Brown (Lorain) [see

Digitized by Google

Abstract No. 1597 (1901)], and other surface-contact systems are briefly outlined, but the conclusion is reached that no real progress has been made in either the underground conduit or the surface-contact system since 1898.

A. H. A.

118. *Narrow* versus *Ordinary Gauge on Light Railways.* **C. de Burlet.** (Tram. Rly. World, 12. pp. 66–69, July 4, 1902. Paper and Discussion read before the International Tramway Congress, July 3, 1902.)—The usual arguments against the narrow gauge are (1) The transport capacity is limited; (2) the necessity for transhipment of goods or passengers at the point of contact with main lines, which is troublesome and costly. Figures relating to the number of passengers per month and the monetary returns disprove the first statement. As to the second, the function of narrow-gauge railways is to first connect country villages with small market towns, and then with the main lines. The author argues that, as the exchange of rolling stock is not practised between certain standard-gauged light railways and the main lines they serve, each company preferring to retain its own rolling stock, the second objection does not carry much weight. The cost of transhipment is only from 1¼d. to 2d. per ton, which includes cost of manœuvring and location of waggons. The advantages of the narrow gauge are (1) The economy in first cost, and (2) economy in working expenses. A table of costs, prepared by Wurmb, gives the costs per km. for lines in countries with topography varying from level to mountainous. For level country the costs per km. vary from 37,500 to 62,500 fr. for 1·450 m. gauge, and from 25,000 to 40,000 fr. for 1 m. gauge, rising to approximately five times these values in very mountainous country. The relative total costs [of which details are given] are 97,000 fr. per km. for the standard gauge, and 44,000 fr. for the narrow-gauge line. The opinion of the Compagnie de l'Appenin Central, based on experience with the Arezzo-Fossate narrow-gauge line, is that the metre gauge is preferable to all others for its traffic. On some of the Belgian local lines it has been found advisable to run three or four lines (that is, both narrow and standard gauge) so as to handle any kind of traffic, viz., heavy traffic on the standard gauge and ordinary traffic on the narrow gauge. The narrow-gauge line allows of a diminution in the number and importance of the engineering works, because it adapts itself better to the configuration of the land, saving heavy embankments and levellings. The maintenance is consequently more economical. The general costs of management and operation are equal for the two systems, but the following table gives the relative costs of the other items :—

	Standard Gauge.		Narrow Gauge.	
	Francs per km.	Francs per Train-km.	Francs per km.	Francs per Train-km.
Maintenance, renewal of rolling stock, and cost of traction	2·475	0·49	1·975	0·39
Maintenance, renewal, and inspection of track	1·735	0·34	1·475	0·29

Discussion.—**L. S. Robinson** spoke of the prejudice of British engineers in favour of the 4 ft. 8½ in. gauge, but he pointed out the good results obtained on the military railways in North India with a 2 ft. 6 in. gauge, and in South

Digitized by Google

Africa with a 3 ft. 6 in. gauge. A broader gauge might be better, but if the authorities had not sufficient money it was better to have a narrow gauge even with transhipment than no railway at all. **L. Janssen** also spoke. In reply, the **Author** emphasised the point that it was not electrical tramways but light railways to which his figures referred, for the accuracy of which he vouched. As to transhipment, they started [on the Belgian lines] with a cost of 2½d. per ton, which they had now reduced to 1d. See] also Abstract No. 991 (1901).] F. B.

119. *Cruvellier Surface-Contact System.* **F. Drouin.** (Électricien, 23. pp. 369–372, June 14, 1902.)—In the usual arrangement of surface-contact systems the contact studs are each connected to one conductor only, the return current passing through the rails. In the Cruvellier system the rails are not used as the return conductor, but two distinct insulated conductors are employed, both of which are led into each stud. The studs, which are oblong in shape, are laid along the centre of the track in the usual way, the longer sides being set at right angles to the line of rails. Beneath the cover of the stud is a lever, pivoted in the centre, engaging at each end with a movable armature. An electromagnet passing over the right half of the stud would lift one armature, and contact with one of the insulated conductors—say the positive—would be made, rendering the stud "alive." Passing over the left half of the stud, the electromagnet would attract the other armature, and the stud would become "alive" but reversed in polarity. Beneath the cars are two sets of magnets, one at the forward and one at the after end. The forward set is to the right of the centre line, and the after set to the left. Immediately beneath each set is a contact skate long enough to touch two studs. When the magnets are energised, therefore, the forward skate would touch positive and the after skate negative studs; and, the skates being connected through a controller to the motors, a completed circuit would be established. As the cars move along the track the studs become alternately positive and negative, and are "dead" as soon as the car has passed. The pivoted lever referred to is merely a safety lever to prevent both armatures rising simultaneously and establishing a short-circuit, and is not rigidly connected to the armatures. F. B.

120. *Electric Suburban Railways.* **E. A. Evans.** (Canad. Elect. News, 12. p. 127, July, 1902.)—In this paper the author gives figures obtained from the working of a line of electric cars on the Quebec, St. Anne de Beaupre and St. Joachim Steam Railway, the cars running on the same track and between the usual steam trains. The author points out that these figures support the arguments of C. H. Davis [see Abstract No. 2181 (1902)], in favour of steam railroads handling their suburban and short-distance traffic electrically. These show, moreover, that this can be carried out on the same track instead of its being necessary to construct a parallel one. G. W. DE T.

121. *Notes on the Wear and Maintenance of Tramways.* **C. F. Wike.** (Elect. Engin. 30. pp. 114–117, July 25, 1902. Paper read before the Association of Municipal and County Engineers.)—The Sheffield specification of rails is as follows:—Girder type, 7¼ in. on flange and 7 in. deep. Weight, 108 lbs. per yard. Analysis: Carbon between 0·35 and 0·45 per cent.; manganese between 0·70 and 1·10 per cent.; silicon not more than 0·1 per cent.; sulphur, arsenic, and phosphorus not more than 0·80 per cent. each. *Mechanical test.*—To be made on a rail 8 to 9 ft. long and supported on iron bearings 3 ft. apart.) A weight of 1,000 lbs. falling 10 ft. is not to deflect the rail

Digitized by Google

more than 1 in. A second blow from 15 ft. is not to deflect it more than 2½ in., and on a third blow from 20-ft., the rail not to show signs of fracture. *Tensile test.*—To be made on a piece machined from head of rail ½ sq. in. area and 2 in. in length. This must stand a tensile stress between 37 and 45 tons per sq. in, with a contraction of not less than 20 per cent. The clearance between lowest point of wheel flange and bottom of groove is $\frac{1}{16}$ in., when the wheel touches, the life of the rail is considered at an end. Before this can happen, 0·706 in. of steel must be worn away. The greatest wear occurs on gradients, through the action of brakes.

A specially difficult crossing of 4 lines has given a good deal of trouble ; but now that the curves have a minimum radius of 60 ft., and the rails, points, and crossings are made of manganese steel (at an expense of some £1,500) the crossing has worked satisfactorily. The average cost of maintenance (not renewal) per mile per annum of single track of different lines of paving has been found to be :—Granite paving, £19 13s. 6d. ; granite paved tracks, macadam sides, £47 9s. 6d. ; gritstone, £49 11s. ; wood paving, £54 8s. 8d. ; tar macadam hit-and-miss setts against rails, £64 13s. 8d. E. K. S.

122. *European Practice in Three-phase Traction.* **C. L. de Muralt.** (Amer. Inst. Elect. Engin., Trans. 18. pp. 411–438, June, 1902.)—The author discusses various European installations, and describes some tests specially made on the Burgdorf-Thun Railway [see Abstract No. 765 (1900)]. With regard to choosing between continuous and alternating systems, the author would consider each case on its merits, but the result of the tests referred to lead him to conclude that, generally speaking, very irregular profile, frequent stops, and great speed variation are all in favour of using continuous current ; but where there is a regular profile, even if the grades are steep, and where there are long runs between the stations, the use of alternating current is indicated. G. W. DE T.

123. *Tube Railways in London.* **P. V. McMahon.** (Tram. Rly. World, 12. pp. 145–147, July 9, 1902. Paper read at the International Tramways Congress, July 4, 1902.)—In this paper, which opens with a short historical account of the development of tube railways, the author discusses the general conditions met with in such lines, illustrating his remarks by a comparison of the results of the working of the City and South London, the Waterloo and City, and the Central London Railways. [See Abstracts Nos. 598, 1597, 1760, 1761, 2519 (1900), and Nos. 276, 1202, 2042 (1901).] The question of rapid acceleration is also discussed. J. G.

124. *Telpherage.* **C. M. Clark.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 391–409, June, 1902.)—The track is usually made of cable, either of standard wire or lock coil type, which latter has the strength of about 95 per cent. of that of the solid bar ; or else of solid rail, either a flat, girder, or bulb type. The track cable is suspended by hangers from "a suspension cable," which is itself supported every 100 ft., except where longer spans are necessary. In solid rail construction, the supports are usually placed from 16 to 20 ft. apart. Cable lines are cheaper, unless there are many switches, and are usually selected for straight lines and moderate weights. Three kinds of telpher are used : (1) Centre-bearing, having two motors, one on each side of the track ; (2) side-bearing, having two motors on the same side ; (3) alternate-bearing, having one motor on each side of the track, but on different shafts. The motors are compound wound for automatic work ; otherwise

Digitized by Google

they are series wound, and a special series coil is commonly employed to increase the starting torque. To better protect the motors from injury, the telpher is placed above the track. The hoist is generally made separate from the telpher, and suspended either below the telpher or below a trailer drawn by it. The brakes employed are either hand brakes or automatic brakes having a solenoid in series with the armature. In automatic lines the middle of the line only is usually kept alive, the end sections remaining dead, except while the operator's hand is on the switch. When passing round a curve, or taking turnouts or crossovers, a resistance is inserted in the trolley circuit, thereby automatically reducing the speed, which varies normally from about 9 miles an hour up to 20 or more. The author observes that it is a revelation to most manufacturers that to carry half a ton on a level track at a speed of 6 miles an hour, much less than 1 h.p. is required, including all losses. The great flexibility of the system with regard to capacity is one of its most important features. G. W. DE T.

125. *Rating of Tramway Motors.* **M. G. Rasch.** (Tram. Rly. World, 12. pp. 28–30; Discussion, p. 30, July 2, 1902.)—The author considers the applicability of the standard rules of the Verein Deutscher Elektrotechniker in relation to tramway motors. During a run of one hour at full load for the determination of temperature rise, no lids or covers are allowed to be opened, nor any artificial air current allowed to replace the ventilation obtained in practice from the motion of the car, but a temperature rise 20° C. higher than for stationary motors may be allowed. The limit would then be, for cotton insulations, 70° C.; for paper insulation, 80° C.; and for mica, asbestos, or other similar preparations, 100° C. In the case of magnet coils a further increase of 10° C. is allowed, but the temperature is then determined by rise of resistance instead of by thermometer, as in the case of armatures. In addition to the output in h.p., the two factors of torque and speed must also be defined. A. E. L.

126. *Testing and Characteristic Properties of Tramway Motors.* **M. B. Field.** (Inst. Elect. Engin., Journ. 31. pp. 1288–1315; Discussion, pp. 1315–1322, Aug., 1902. Paper read before the Glasgow Section, April 8, 1902.)—The author gives reasons for the most satisfactory manner of arriving at the

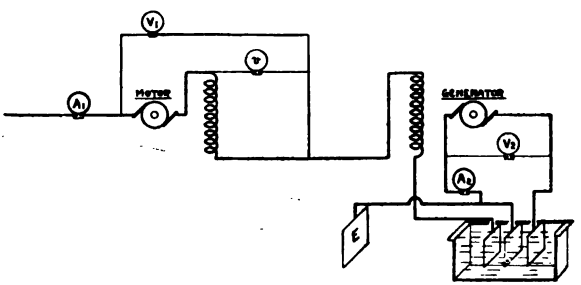


FIG. 1.

merits of different types of motors, and explains the special test which he has devised to supplement those usually carried out on a tramway route. Two exactly similar machines are mounted on a frame and geared together through their respective pinions with one of the car gear wheels. The one machine acts as a motor and the other as a generator, or *vice versâ*. The electrical

Digitized by Google

connections are arranged as shown in Fig. 1, for an efficiency test at 250 volts from the supply mains. Since the two machines are identical in every respect, it is assumed that the iron and friction losses in each are the same. Then, A_1V_1 = input; A_2V_2 = output. Hence, $A_1V_1 - A_2V_2$ = total loss in motor and generator, but exclusive of the generator's field. Also $A_1^2(mR_a + mR_f + A_2^2gR_a$ = the known ohmic losses. Now, subtracting the ohmic losses from the total loss, the remainder gives the total loss in motor and generator, as covered by hysteresis, eddies, friction, windage, &c. Half of this loss is apportioned to the motor and half to the generator. The efficiency of the motor is then easily calculated. An actual example with all the necessary numerical results is then given. The slight alterations for a test at 500 volts, with a diagram of the connections and various characteristic curves as plotted from the results are fully illustrated, of which the following is a sample :—

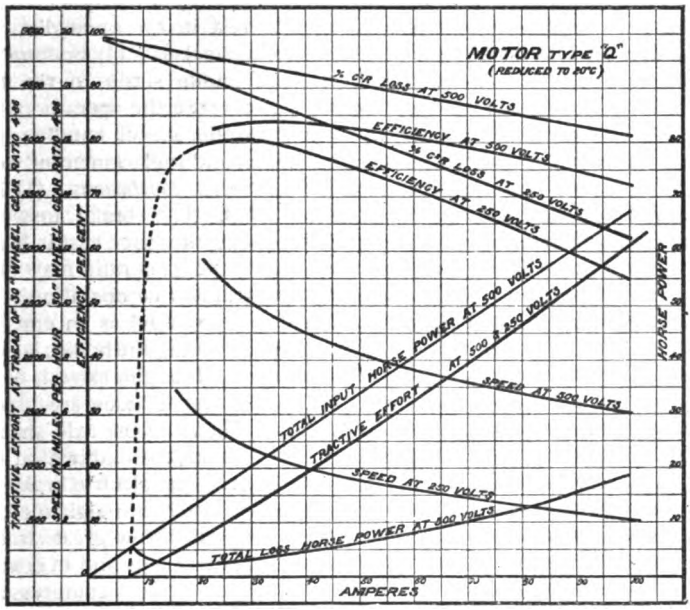

MOTOR TYPE "Q"
(REDUCED TO 20°C)
% CAR LOSS AT 500 VOLTS
EFFICIENCY AT 500 VOLTS
% CAR LOSS AT 250 VOLTS
EFFICIENCY AT 250 VOLTS
TOTAL INPUT
HORSE POWER AT 500 VOLTS
AT 500 & 250 VOLTS
TRACTIVE EFFORT
SPEED AT 500 VOLTS
SPEED AT 250 VOLTS
TOTAL LOSS HORSE POWER AT 500 VOLTS
AMPERES
HORSE POWER
TRACTIVE EFFORT AT TREAD OF 30" WHEEL GEAR RATIO 4·08
SPEED IN MILES PER HOUR 30"- WHEEL GEAR RATIO 4·08
EFFICIENCY PER CENT

FIG. 2.

The paper contains 22 figures, 13 tables, with final mathematical and physical notes. *Discussion.*—**H. A. Mavor** desired further detailed data in regard to the mechanical and electrical designs of the motors which had been supplied to the Glasgow Corporation tramways. **A. Jamieson** thought that the author had stuck very fairly to his text, and stated that he had shown how to ascertain : (1) What was the mean working effective current required for particular tramway routes, and as a whole for the Glasgow system ; (2) the type of tramcar motor which gave the greatest efficiency at the mean working current ; (3) the conclusions derivable from (1) and (2) by aid of calculations, diagrams, and characteristic curves, whereby a set of working rules could be drawn up for instructors, inspectors, and drivers, with the view of lessening the working expenses. **W. McWhirter** suggested that the very high heating factor allowed for tramway motors appeared to require further elucidation, and asked the best authority on tractive efforts as required under

Digitized by Google

different conditions of the tramway rails. The **Author** (in reply) gave cogent reasons for the particular manner in which he had treated the subject, and answered the inquiries of those who took part in the discussion. A. J.

127. *Brake Systems on Electric Tramcars.* (Tram. Rly. World, 12. pp. 166–168, July 10, and pp. 194–196, July 11, 1902. Report read by **Poetz** before the International Tramways Congress, London, July, 1902.)—A list of the types of brakes used by twenty companies affiliated with the Permanent Tramway Union is given, together with the rules adopted by many of these companies on the subject of braking. The experiences of Tramway Companies in different countries, with various forms of brakes, viz., hand, electric, pneumatic and belt, under varying climatic conditions, are summarised. Broadly, the conditions are: (1) That each car should be equipped with two independent brakes; (2) that the car must be brought to rest within the shortest distance permissible by local conditions; (3) when descending the steepest grades, the car must be brought to rest in the same distance as previously, but only after the speed has been checked; (4) braking to be smooth, to avoid shocks to passengers and undue strain to the truck; (5) operation of brake to be easy, so as not to overtire the operator, and the brake handle must not interfere with the controller switch handle; (6) the brake to admit of easy inspection and regulation, and replacement of wearing parts; (7) cost of maintenance to be low. *General conclusions.*—(1) *Hand-chain Brake.* Usual gearing ratio, 1/80 or 1/100. This brake answers for ordinary requirements if no trailers used. Its maintenance cost is low, and the parts are accessible. With the *Screw Brake* the gear ratio may be over 1/100, but this is inconvenient owing to the tardiness of operation. Street mud and dust cause rapid wear. It should only be used as an emergency brake. (2) *Electric Brakes.* When the current actuating the brakes is derived from the motion of the car, the latter cannot be brought to rest, so hand brakes should be used in addition. If electric brakes alone are used, the current should be obtained directly from the line. Every axle should be braked. With cars run singly, the short-circuit brake, in combination with a hand brake, answers every condition of reliability. The electric brake is less tiring to the motor-man than the hand brake, especially with high speeds and frequent stoppages. It is stated that electric brakes throw great strains on the motors, entailing heavy cost of repairs to armature coils, and in congested traffic overheating occurs. (3) *Pneumatic Brakes.* The compressed air brake claims advantage over electric, in that trailers can be added without additional motors, controllers, &c. Against them, however, are the higher initial cost, the necessity for a special controlling handle, increased working expenses caused by the compression of the air, extra inspection due to valves, &c., the freezing of pipes, and reduction of braking efficiency when snow gets between the shoes and the wheels. A brake which may be perfectly reliable on small cars at a moderate speed, is useless on heavy cars running at high speeds. F. B.

128. *Brakes for Tramcars.* **C. J. Spencer.** (Tram. Rly. World, 12. pp. 87–88, July 5, 1902. Paper read before the Association of Municipal Tramway Managers, July, 1902.)—Results of some brake tests made on a single track 52-passenger car at Bradford. The tests were made on a level track with a wet rail, and the car, which was equipped with hand, electric and slipper brakes, was drawn by two ordinary cars through a dynamometer drawbar. A second dynamometer was connected to the pull-

Digitized by Google

rod of the slipper brake, from which the downward thrust of the wooden slipper block against the rail was calculated. With the hand brake alone a maximum retarding effort of 2,050 lbs. was reached before the wheels skidded. On locking the wheel, causing skidding, the figure fell to 1,600 lbs. With the slipper brake alone the maximum retarding effort was 950 lbs., the corresponding pressure on the rails being 4,300 lbs. With the hand brake in addition the combined retarding effort was 2,450 lbs., showing an advantage of 400 lbs. over the hand brake alone. This is under the worst conditions (for the slipper), viz., a wet rail. A greasy rail cannot exist on steep gradients where the slipper is in constant use. Two charts based on the tests are given. F. B.

129. *Electric Brakes.* **M. Müller.** (Elektrotechn. Zeitschr. 23. pp. 515–521, June 12, 1902.)—From the characteristic curves connecting torque and speed with current strength of a tramway motor the braking effects when acting as a generator with different speeds and different external resistances are obtained by graphical construction. It is pointed out that there is danger of excessive currents with careless handling, while, unless the contacts for the resistance be made very numerous, the braking effect varies considerably, so that the average is considerably below that corresponding to the coefficient of friction on the rails. If this maximum effect could be secured the distance in which a car could be stopped would depend only on its speed and on the coefficient of friction $s = v^2/19{\cdot}62a$, where s represents the distance in m. occupied in stopping, v the initial velocity in m per second, and a the coefficient of friction. The Westinghouse-Newell track brake is described. In this an electromagnet, excited by the motors acting as generators, grips the rail with a pressure which may reach two tons. The drag on it, due to its friction, is made to force the ordinary brake shoes on the wheels. By this means an actually greater braking effect may be attained that would correspond to the whole weight of the car. A. E. L.

130. *Tramway Brakes.* **Poetz.** (Tram. Rly. World, 12. p. 66, July 4, 1902. Paper and discussion read before the International Tramways Congress, July 3, 1902.) (Abstract.)—Tests on tramway brakes at Hamburg showed that at a speed of 14 km. the Helios magnetic brake pulled up in 15·5 m. and four others in 9 m. At other speeds the following results were obtained :—

Speed in km. per Hour.	Distance required to pull up.				
	Siemens and Halske (E).	Schuckert (E).	Helios (E).	Standard (A).	Carpenter (A).
20	18	15	21	16	16·7
28	17·8	24·5	27·2	23·6	24·2
32	27·2	43	43·5	38 8	35·8

E = electromagnetic. A = air.

The author argues that electromagnetic brakes are simpler and need less attention than air brakes, but that the two systems are equally effective in ordinary work. *Discussion.*—**Thonet** confirmed the author's figures. At Marseilles the cost of installing air brakes was 200,000 francs per motor

Digitized by Google

and trailer, against 600 francs for the electric. **Gustave Koehler's** experience in Berlin was that the air brake was more reliable than the electric. The magnetic brake cost more for cleaning, and caused more shock in pulling up the cars. As to initial cost he disputed the author's figures—one gave 1,200 marks per car and trailer for the air brake, against 1,050 for the electric. For repairs the cost came out at 170 marks for electric against 127 for air. **von Leiber,** basing his opinion on his experience in Vienna, agreed more with the author than with Koehler. In reply the **Author** attributed the poor results obtained by Koehler in Berlin to the type of brake chosen, and pointed out that great improvements had been made since the Sperry brake was adopted there five years ago. F. B.

131. *Employment of Rolling Stock.* **J. H. Neiszen.** (Tram. Rly. World, 12. pp. 224–226, July 12, 1902.)—In a report to the International Tramway Congress the author states that suburban tramways form exceptions to the rule that a reduction of the tariff raises the ratio of passengers carried to seating capacity. Further, to cope with variations of traffic it is better to use trailers than to have cars of different sizes. The author then discusses the effect of local conditions, the season of the year, the weather, &c., on the proportion of seats occupied, which also varies enormously according to the time of day. The statistics available are conflicting and incomplete. A. H. A.

132. *Arrangement of Car Sheds.* (Tram. Rly. World, 12. pp. 153–154, July 9, 1902. Abstract of a paper by **M. A. Trantweiler,** read before a meeting of the Tramways Congress, London, 1902.)—The author discusses the contributions of seventeen different tramway companies in reply to the following questions:—How do you consider the car sheds ought to be placed with regard to the form of the network and the services carried out on your lines? Are you of opinion that the cars should be concentrated in a limited number of important sheds, or distributed in a greater number of less important sheds? Discuss the question from the point of view of rolling stock, of utilisation and inspection of the staff, and of the lost journeys made by the cars at the beginning and end of the day. How far have you been able to realise your views, that is to say, how are your sheds placed, and what are the advantages and disadvantages which you have experienced in this arrangement? Seven of these contributions, by referring to more or less important considerations, point out the desirability of concentration, whilst the other ten advocate the erection of a greater number of depôts. The importance of the limitations imposed by local circumstances is emphasised by most of the companies, but, in general, it may be said that concentration is recommended in the case of small and medium-size systems, whilst with very large systems absolute concentration is considered to be impossible. The Barmen-Elberfeld Company [see Abstracts Nos. 1593 (1900) and 605 (1902)] draws a distinction between urban and suburban lines, and the Magdeburg Company calls attention to the great risk in case of fire, when a large number of cars are concentrated in one depôt. J. G.

133. *The Electrical Equipment of an Ordinary Street Car.* **A. B. Lambe.** (Electricity, N.Y. 23. pp. 78–79, Aug. 13; 93–94, Aug. 20; and pp. 103–105, Aug. 27, 1902. Paper read before the annual meeting of the Canadian Electrical Association, Quebec, June 11, 1902.)—The paper describes the various pieces of mechanism of a street car. It is mentioned that the pressure of the

Digitized by Google

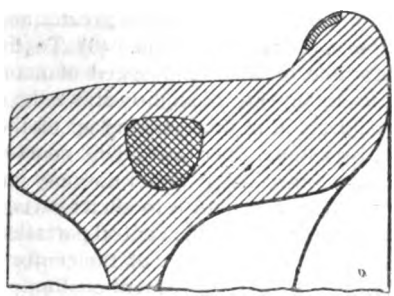
trolley wheel against the wire is 20 to 40 lbs., which, after the addition of the pressure necessary to balance the wheel, harp, and pole, means a tremendous stress on the trolley standard and car superstructure; few realise how large it is. Where there are four motors, it is necessary to have a complete reversing switch to each motor, otherwise there will be very unequal field strengths, and the motors will not share the load equally.

Some interesting remarks are made on the subject of wheel-slipping. The following are stated to be average figures in America:—

	Motors.	Weight with Controllers. Tons.	Total weight of Car. Tons.
Ordinary street car.....	Two of 35 to 40 h.p.	8½	12
Car for interurban high-speed service	Four of 50 to 80 h.p.	8 to 12	25

E. K. S.

134. *Cast-iron Wheels under Heavy Cars.* (Railroad Gazette, 34. pp. 430–432, June 13, 1902.)—There have been many reasons for the belief during the last year or two that the chilled cast-iron wheel was not up to the service of 100,000-lbs. capacity cars. When tried with these cars, wheels of this type failed in a way which showed them to be unfit for service, although they had given no trouble whatever under cars of 80,000 lbs. capacity. Examination showed that the trouble mostly occurred on mountain roads in the form of breakage at the flange, circumferential cracks first developing which caused the flange to break off. The same tendency for the cast-iron wheel to break under high-capacity cars manifested itself also on the level roads, although not so quickly. It seems certain that the causes of these fractures were (1) the



heating of the wheels by the brakes, (2) the weight of the car throwing a destructive stress on the wheel on curves, and (3) the construction of the car being such as to put an excessive weight on the side bearings, thereby cramping the trucks while running from a curve to a tangent, or *vice versâ*. Wheels of a heavier type have now been designed and put into service, weighing from 75 to 100 lbs. more than those previously used, and, although they are not entirely satisfactory, they appear to stand the strain better than the lighter type. The same trouble has appeared in a somewhat different manner, but not to the same extent. The cracks in this case appear normal to the tread and parallel to the axle, and, while not being as dangerous as the other, nevertheless serve for the condemnation of the wheel. Investigation has resulted in some interesting developments. Thus it was found that the cracks frequently occurred in the body of the metal rim, as shown in the sketch, in which the double-hatched portion represents the cracks. No inspection would

Digitized by Google

have detected such a crack, which was attributed to brake action, in which the tread expanded and put such a tensile stress upon the grey metal beneath as to crack it. This was proved by producing the same sort of crack artificially. In addition to increasing the weight of the wheels, a slight change has been made in some places by increasing the amount of charcoal pig from 15 to 20 per cent. C. E. A.

135. *Structure and Finishing Temperature of Steel Rails.* **A. Sauveur.** (Mech. Eng. 10. pp. 11–18, July 5, 1902. Paper read before the International Association for Testing Materials, American Section, June 18, 1902.)—After criticising some recent departures in rail finishing, the author says that three courses seem open, in order to confer a fine-grained structure upon steel rails, viz., (1) To shorten the crystallising period, *i.e.*, the time during which the rail is allowed to cool undisturbedly above the critical temperature (say about 700° C.). In other words, the rail should be finished sufficiently cooled, and the finishing temperature, will, of course, depend in turn upon the temperature of the ingot when rolling begins, and upon the speed of the operations. The main objection to starting and carrying the rolling at a relatively low temperature is that it throws more work upon the rolls. The objection to a slow-rolling speed and handling of the material is that it decreases the output of the mill. Both objections imply an increase in the cost of the rail. (2) To cause a part of the crystallising period to occur previous to the final pass, *i.e.*, allow the rail to cool undisturbedly at some stage of the operations, and for a short time before completing the rolling. This cooling, in order to be effective, should occur at a sufficiently early stage of the rolling, in order that the resulting crystallisation may be broken up through a sufficient amount of subsequent work and reduction. Such results would be obtained by placing the cooling table at the shears. The objection to this course is that the shaping of this cooler bloom into rails would require greater mechanical effort, and therefore increase the cost of production. (3) To finish the rail at the temperature most desirable for ease and speed of manipulation, in rolling, and then to reheat it to a temperature slightly above the critical temperature, a treatment which would result in the breaking up of the pre-existing coarse structure, replacing it by a much finer one. This course would undoubtedly be the most effective of the three, as it would not only impart a fine structure to the rail, but also a *uniform* structure to all its parts, while a rail not so treated must necessarily be coarser in the central parts than nearer the cooling surfaces, owing to the higher temperature of the centre when the rail leaves the finishing rolls and to its slower subsequent cooling. The cost of such reheating treatment would undoubtedly be very great, and, possibly, prohibitive. G. W. DE T.

136. *Tests of Spring and Friction Draft Gears.* (Railroad Gazette, 34. pp. 428–429, June 18, 1902.)—In a report of a committee of the Western Railway Club on underframing, based largely upon the result of a series of tests made on the Lake Shore and Michigan Southern and the Bessemer and Lake Erie, with the dynamometer cars of the Westinghouse Air Brake Company, the conclusion arrived at is, that whatever one may think of the details of the various friction-draft gears, it must be evident that in character and amount of resistance they are superior to the spring gears. The tests were made in order to determine the amount of shock experienced in ordinary service; the amount of shock in extremely rough service; the behaviour of the two types of gears within their capacity; and the behaviour of the gears

Digitized by Google

beyond their capacity. It was found that the spring gear is inadequate to take care of even the most ordinary shocks, and is inferior in cushioning shocks beyond the capacity of either type. In the case of the friction gear the effectiveness of this was shown in taking care of shocks up to its capacity of 140,000 lbs. or beyond, and also its superiority in dealing with shocks beyond the capacity of both gears. C. E. A.

137. *Automatic Block Signals on the Liverpool to Manchester High-Speed Railway.* **L. Kohlfürst.** (Zeitschr. Elektrotechn., Wien, 20. pp. 317–321, June 29, 1902.)—This paper first briefly describes the construction of the permanent way, gradients, curves, stations and motor vehicles, giving dimensions and other numerical data. As regards the signals, the conditions are that during working hours a car shall start from each of the terminal stations every ten minutes. The line is divided into five block sections of almost equal length, each approximately 11 km. long, with six signal-points, those next the termini serving as departure and arrival signals. At each of these points there is an external semaphore which is arranged at the right-hand side of the corresponding track, and, as usual, indicates "danger" or stop when horizontal (red light), and "all right" or line clear when inclined downwards at 45° (green light); and a small signal in the signal-box which exactly follows the movements of the signal on the line. The semaphore arms of both these signals are moved by solenoidal electromagnets in such a manner that when the solenoids are de-energised, the signals are brought to "danger" by weights, and are held at "all right" by the action of the current, which is supplied from batteries. In each signal-box there is an electromagnetically operated feed-pawl actuating a six-tooth ratchet-wheel, which is mounted on a shaft bearing two sets of three switch-arms (Nos. 1 and 2) arranged at 120° to each other, each set co-acting with two fixed contact-pieces arranged diametrically opposite to each other, so that one of the movable switch-arms of each set makes contact with one or the other of the corresponding fixed contacts alternately each time the ratchet-wheel is turned through an angle (60°) corresponding to one tooth by the feed-pawl. At each signal-point four insulated contact rails are arranged parallel to the line above the track and co-act with four sliding contacts mounted on the top of each motor vehicle, two of these sliding contacts being connected together to form a bridge-piece, and the other two being connected together through a battery and an electric bell or indicator. When the signals at any box (*e.g.*, No. III.) are at "all right," the circuit including their operating electromagnets is closed through the battery and at switch No. 1 at that station, and through switch No. 2 at the next station but one in advance (*e.g.*, No. V.). On a motor vehicle passing a signal-box (*e.g.*, No. III.), the "bridge-piece" contacts on the vehicle close a circuit, including the battery and the electromagnet of the feed-pawl at that box, whereupon the switch-arms are turned through 60°, thus causing the circuit of the signal-electromagnets to be broken at one fixed contact of switch No. 1 at that station, and the signals to move to "danger." At the same time another of the switch-arms of switch No. 1 makes contact with the other fixed contact of this switch, which contact is connected with the corresponding contact of switch No. 2 at box No. V., so that when the vehicle reaches box No. V. the circuit of the signals at box No. III. will be again completed and these signals will again drop to the "all right" position. Thus, before a vehicle is allowed to pass any signal (*i.e.*, before any signal can drop to the "all right" position), there must be two clear block-sections in front of it. Signals I. and II.

Digitized by Google

obviously are not provided with No. 2 or clearing switches, whilst the contacts for the clearing switches of signals V. and VI. are arranged in the arrival station for that line. In order to warn the driver of a vehicle passing a signal in the "danger" position, the signal, in this position, is caused to close a switch which short-circuits the other two of the four fixed contact rails arranged above the rails at each signal. These short-circuited contact rails form a bridge-piece which completes the electric bell circuit on the vehicle and warns the driver of the "danger" signal which he is passing. This bell is arranged so as to continue ringing until stopped by the driver. [See also Abstracts Nos. 307 (1901) and 2851 (1902).] C. K. F.

138. *Modern Electric Block Signalling.* **E. F. Bliss.** (Elect. World and Engineer, 40. pp. 279–284, Aug. 23, 1902.)—The principles and methods have been mostly described in previous Abstracts. The Union Switch and Signal Company use the track only and no line wires: hence the system is named "wireless." The track relay has, besides the ordinary neutral armature, a polarised one which closes the circuit for the "caution" signal.

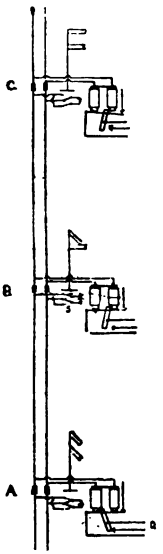


FIG. 1.

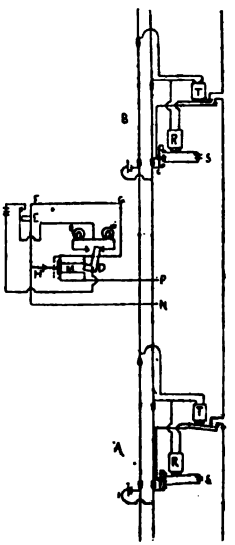


FIG. 2.

When the top blade at B in Fig. 1 goes to the clear position, the signal rod throws a pole-changing switch S, which reverses the direction of the current in the track running back to A. This reversal at A causes the polarised armature to close the circuit D, which extends through a battery and to the mechanism of the caution blade at that station, bringing it to a clear position. One advantage in a track circuit is that, if a rail breaks, the signal at entrance to the block goes to "stop" position. All switches are wired so that when one is opened the track battery is short-circuited or opened at that point which sends the signals to "stop" position. Track circuits preferably require coarse gravel or broken stone as ballast up to 1 in. below the top of the tie. Rail bonds can be No. 8 galvanised wire, the ends of the wire being wrapped round iron rivets and soldered. The rivets are driven into quarter

Digitized by Google

inch holes drilled in the flange or web of the rail; or the end of the wire may be wedged into the hole with a pin. Bond wires are double, under or outside the fish-plates, on both sides of the rail, or both on the inside, which is best for inspection. Insulated joints are made by putting in a piece of fibre about $\frac{1}{8}$ inch thick and shaped like the cross-section of the rail: the fish-plates are made of wood bound with iron, and the bolts insulated with fibre. The Miller signal introduced on a few miles of the Chicago and Eastern Illinois Railroad provides lamps on the locomotive, and dispenses with posts. There is one red and one white lamp, each of which burns separately, indicating "danger" or "line clear" as usual. Fig. 2 illustrates the connections. The track is divided into insulated blocks with track batteries and track relays, a short block being left between the regular blocks at each block station. The equipment of the latter is this short block, the station relay, and the station battery, no semaphore or disc signals being used. The apparatus on the engine is shown to the left of the track. One terminal is connected to the locomotive wheel, the other to one of the tender trucks which is insulated from the rest of the train. These two terminals therefore rest on the track in the positions shown in the Figure. Should any derangement cause both red and white lamps to fail the engineer proceeds as if a danger signal had been received. Batteries commonly used on track circuits are gravity as for telegraphy, two or three cells in parallel located in pits to secure against frost. For signals the Pennsylvania Company uses six storage cells charged from a distance by a 500-volt generator, and changed daily, one set being in reserve. The cells were in wells 7 ft. deep, of iron lined with wood, with double covers. The Union Pacific Railroad uses ten gravity cells; the Union Switch and Signal Company sixteen cells Edison-Lalande, which does not require a well to protect from frost. E. O. W.

REFERENCES.

139. *Report of a Deputation from the Institution of Electrical Engineers to the President of the Board of Trade on the Subject of Legislative Restraints on Electrical Enterprise.* (Inst. Elect. Engin., Journ. 31. pp. 1323–1327, June, 1902.)

140. *Cuantillan Power Transmission, Mexico.* (Eng. and Mining Journ. 73. p. 802, June 7, 1902.)—The paper describes a small turbine installation for supplying power to the Compania Industrial La Aurora. G. W. DE T.

141. *European Electric Railway Practice.* **H. Vellguth.** (Street Rly. Journ. 19. pp. 409–443, June, 1902.)—The author compares electric street railway practice in Europe and America, both from the constructional and financial points of view, and gives descriptions of, and discusses financially, a number of European street and other light electric railways. G. W. DE T.

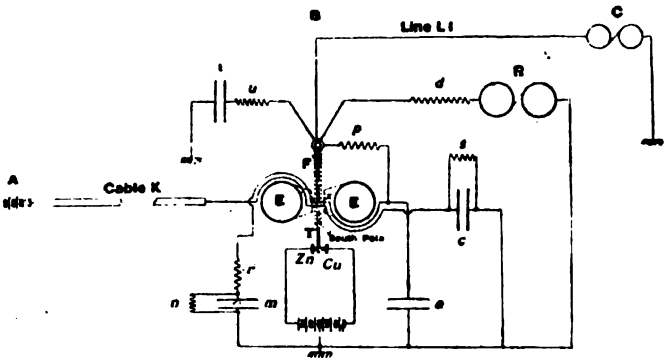
142. *Freight Business on the Chicago, Harvard, and Geneva Lake Railway.* (Street Rly. Journ. 19. pp. 457–459, June, 1902.)—The paper contains an illustrated description of the freight cars and freight work on this line, and considers the freight charges and earnings. G. W. DE T.

Digitized by Google

TELEGRAPHY AND TELEPHONY.

143. *Vibrating Cable Relay.* **K. Gulstad.** (Elect. Rev. 51. pp. 294–295, Aug. 22, and pp. 332–334, Aug. 29, 1902.)—The arrangement of the relay is shown in the diagram. The tongue is vibrating and the adjustments are made by altering resistances and capacities.

The employment of a double set of windings—one for the cable circuit, another for the local relay circuit has proved advantageous by reducing induction disturbances. The sensitiveness of the movement of the tongue is secured by regulating the resistance *p*; when this is sufficiently decreased the tongue vibrates. The condenser *t* prevents sparking, but the resistance *u* is introduced in order that with low-resistance relay batteries *t* may not originate sparking itself. Condenser *a* is designed to curb the movements of the tongue. Good contacts are also secured by having the poles of the electromagnets very much closer to the armature than usual, whereby, of course, the



A, The cable station; B, The translating station; C, The receiving station. At station B, E, Electro-magnets of relay (upper poles); F, Armature of relay (say, south pole); T, Tongue of relay; Zn and Cu, Zinc and copper poles of relay. *c*, Condenser, *s*, Resistance, belonging to cable circuit through one relay winding; *a*, *m*, Condensers belonging to local relay circuit; *r*, *n*, *p*, Resistances belonging to local relay circuit; *t*, Condenser, *u*, Resistance, in connection with tongue; R, Receiving apparatus in leak circuit; *d*, Resistance in leak circuit; L_1, Line in connection with relay tongue.

action of the cable current is also increased. For moderate speeds it is arranged that the rate of vibration of the tongue shall nearly correspond to the number of dot signals from the cable; when this is so the interference of the cable-current dots on the vibrations produced by the local current would shortly bring the two kinds of impulses into coincidence. At higher speeds, however, they would only partially fulfil this function, owing to the small amplitude of the responding current strength, the prolonged positive and negative signals, the "dashes" thus only controlling the right translation of the relay. The author here effects adjustment by altering *r* and *p* as well as capacity *a*. The vibrating relay on the above principle is used in connection with several of the Great Northern Telegraph Company's cables. On the Newcastle-Gothenburg-Nystad circuit the possible speed of working was increased from 30 to 120 words per minute by this improved method.

E. O. W.

Digitized by Google

SCIENCE ABSTRACTS.

Section B.—ENGINEERING.

FEBRUARY 1903.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

144. *Balanced High-speed Engine.* (Engineer, 94. pp. 116–117, Aug. 1, 1902.)—Description of Bever's patent balanced engine. The engine has two horizontal cylinders tandem on each side of the shaft; the cylinders on one side operate the centre crank, and those on the other side operate the outer cranks by means of a forked rod, the outer cranks being at 180° to the centre crank. The moving parts being of equal mass, a perfect balance is obtained, which allows of the high speed of 800 r.p.m. The back end of the high-pressure cylinder is continually exposed to steam at full pressure, thereby maintaining thrust in the rods; steam is admitted to the front end of the high-pressure cylinder and cut-off at about half-stroke, thence to the back end of the low-pressure cylinder with about the same cut-off, finally to the front end of the low-pressure cylinder. The distribution of steam to the two cylinders is effected by one piston valve operated by an eccentric; the engine is of course enclosed and has the crank running in an oil-bath.

H. R. C.

145. *Tests of Steam Turbine at Hartford, Conn.* **W. L. Robb.** (Elect. World and Engineer, 40. pp. 860–861, Sept. 6, 1902.)—The turbo-generator installed at Hartford is rated at a capacity of about 2,000 kw. [see Abstract No. 1454 (1902)]. The steam used for the turbine tests was superheated about 88° Fahrenheit. The load during the months of January, February, and May varied from 864 kw. in May to over 2,000 kw. in February. The steam pressure was kept at about 150 lbs., barometer 30 in.; vacuum at turbines from 26·9 to 27·4 in.; coal consumption per e.h.p.-hour from 1·28 to 2·49 lbs., or per kw.-hour from 1·70 to 3·32 lbs. The steam consumption per e.h.p.-hour was from 14·48 to 25·10 lbs., or per kw.-hour from 19·10 to 33·47 lbs.

L. G.

146. *Indicator Diagrams.* **A. K. Mansfield.** (Amer. Soc. Mech. Engin., Trans. 23. No. 937. pp. 511–516; Discussion, pp. 516–519, 1902.)—The author advocates taking a diagram from the steam pipe near the valve as well as from the cylinder, and for this purpose uses a four-way cock. It was pointed out

Digitized by Google

in the discussion that the oscillation in steam-chest pressure, due to insufficient receiver space or to the supply pipes being too small, would account for the difference in the initial pressure at the two ends of the cylinder which is sometimes seen on the diagrams, although the valves are correctly adjusted. H. R. C.

147. *Power Meter.* (Power, N.Y. 22. p. 45, Aug., 1902.)—This is an apparatus, patented by A. F. Nagle, for measuring the i.h.p., or rather the indicated work in a given time, at one end of an engine cylinder. The drum of an indicator is replaced by a vertical disc, which oscillates about a horizontal axis, copying the motion of the piston in the usual way; the cylinder, piston, and spring of the indicator are as usual, but the piston rod carries a small friction wheel which rotates about a vertical axis and is pressed against the vertical disc when the instrument is in action; the nett amount of rotation of the friction wheel is registered by means of dials. The amount registered in the working stroke is proportional to the mean height of the wheel above the centre of the disc during that stroke, while the amount subtracted on the back stroke is proportional to the mean height of the wheel during the back stroke, so that the amount registered in a given time represents the work done at that end of the cylinder in that time. The length of the stroke of the vertical disc is measured by means of two lugs, which are attached to circular scales and are caused to separate to a distance equal to the stroke of the disc by a third lug attached to the disc. From this and the dimensions of the engine the constants to convert the amount registered into either i.h.p. or work done are readily found. [This instrument is somewhat similar to W. G. Little's Integrating Indicator, in which the end of the piston rod alters the inclination of a planimeter wheel which is rotated by a hard brass bush on the vertical cylindrical drum, in which case the amount registered and the mean difference of pressure are both proportional to the mean difference of the sines of the inclinations of the axis of the wheel during the two strokes.] H. R. C.

148. *Monarch Engine Stop and Speed Limit.* (Electrician, 49. pp. 705–706, Aug. 22, 1902.)—The stop is a device for closing the steam valve of an engine by means of a falling weight with an electrical release. The release may be operated from any of several push-buttons placed in various parts of the factory if occasion arises, or by the speed limit [which is similar to an ordinary governor] if the speed of the engine becomes excessive. H. R. C.

149. *The Garbage Furnaces of Trenton.* (Eng. News, 48. pp. 197–200, Sept. 11, 1902.)—This is a reproduction in print of the report made by R. Hering, of New York, to the Committee "appointed to investigate the working of the city crematory, against which numerous complaints have been made." It is said to be the first complete engineering investigation of the operation of an American garbage furnace which has been published, and is expected to mark an era of improvement in garbage disposal there. The causes of complaint are ranged under the following heads which are treated separately: (1) Collection of garbage and odours arising from it when delivered at the works. (2) Odours from the ashes after their removal from the furnace, when retaining some incompletely burned material. (3) Dust of completely burned garbage escaping from the stack and depositing in the neighbourhood. (4) Unburned or still burning particles escaping from the stack and depositing in the neighbourhood, with the possibility of causing

Digitized by Google

fires. (5) Odours due to the unburnt gases escaping from the stack. The destructor plant reported upon consists of two furnaces of the Davis type connected by separate flues to a brick chimney of 5 ft. square internal section, about 120 ft. high from the base, and 100 ft. above the entrance of the flues. Each furnace consists of a drying chamber at the back, 8 ft. square and 8½ ft. high to the crown, and a combustion chamber at the front, 4 ft. long, 6 ft. wide, and 4 ft. high, on the same level as the drying chamber, both having horizontal grate bars about 4 ft. long and 4 in. wide, with ½ in. openings for the fire grate and ¼ in. wide for the drying grate. The main flue is about 3 ft. wide by 3½ ft. high, and there is a secondary flue 4½ ft. long, 5½ ft. wide, and 3 ft. high, containing some short grates on which coal is kept burning for the purpose of destroying odours passing from the furnaces. The refuse is similar to that of other towns (see Table).

Towns	London.	Berlin.	New York.	Boston.	Trenton
Authority	Codrington.	Bohm & Grohn.	Craven.	O'Shea.	Committee.
Kitchen garbage, animal, and vegetable matter	77	82	64	84	84
Paper	23	11	28		12
Rags, clothing, carpets, &c.		3			3
Boxes, barrels, and Other rubbish		4	8	16	1

American experience of destructors is considerably behind that of countries in Europe—the American furnace has larger grate area and horizontal instead of sloping bars. Irregular burning is caused by the dumping of damp refuse on such grates; and the rate of combustion and of travel of the waste gases is, especially at Trenton, much too high. The amount of garbage burned in each English cell depends on its composition and moisture, but with proper drying it is usual to burn 5 to 7 tons per day per cell of 25 sq. ft. grate area; and the quantity of unburnt coal mixed with the ashes in the collected refuse furnishes all the combustible required to ensure thorough burning. In Trenton the quantity burned per day is almost 14 tons, and to aid combustion about 120 lbs. of additional coal per ton of refuse are used. In consequence of the confined area of flues and of badly designed dampers, the velocity of the currents of waste gases is too great. With proper grate area for the burning of 30 tons per day the volume of air required for the combustion would be about 150 cub. ft. per second, which would demand a sectional area of at least 100 sq. ft. in the flues, or more than four times the existing area. The writer recommends the erection of new furnaces of the English pattern, and drying chambers, with sloping floors to aid in drawing off moisture from the refuse, and also in moving charges into the furnace; a better arrangement of dampers to control the draught towards the chimney at different periods of the work; more flue area and the interposition of a dust-settling chamber between the furnace and the chimney. The furnaces should be worked with forced combustion, and all the unburned coal collected with the refuse should be left in it, in order to save the additional coal at present used. The gases should leave the furnace at a point above the hottest fire, and should be utilised to heat the walls of the drying chamber, and assist in preparing the garbage for burning. There are also several minor recommendations which deal with the transit and stowage of the refuse. F. J. R.

150. *Liquid Fuel.* **J. W. Warren.** (Electricity, N.Y. 23. pp. 102–103, Aug. 27, 1902. Paper read before the National Electric Light Association at its 25th Convention, Cincinnati, O., May 20–22, 1902.)—This paper deals with

Digitized by Google

the use of liquid fuel in the State of California, and contains some interesting details. The Californian oil is peculiar in containing about 80 per cent. of asphalt and very little paraffin. The oil wells are about 1,000 feet in average depth, and the oil has an average sp. gr. of 15° Beaume and temperature of 70° F. When used for boiler firing it is pumped at 20 lbs. per sq. in. pressure through heater pipes, which raise it to a temperature of 190° F. before it is sprayed. F. J. R.

AUTOMOBILISM.[1]

151. *High-speed Motor Trials.* (France Automobile, 7. pp. 602–603, Sept. 20, 1902.)—The paper gives the results of further investigations on high-speed petrol and alcohol engines by means of the Mathot pressure recorder. [See Abstract No. 1879 (1901).] Diagrams and readings of pressure in all portions of the four-stroke cycle are given, showing the maximum explosion pressure attained, and the losses due to back pressure and partial vacuum on the exhaust and suction strokes respectively. C. R. D'E.

152. *Clement Light Car.* **L. Fournier.** (Locomotion Automobile, 9. pp. 596–599, Sept. 18, 1902.)—This is a light four-seated car, fitted with a double cylinder, vertical petrol engine, rated to give 8 h.p. at 1,100 r.p.m., the cylinder proportions being 85 mm. bore × 110 mm. stroke. The engine is water-cooled and fitted with electric ignition; it is mounted towards the front of the underframe and enclosed by a bonnet. The transmission mechanism comprises a cone friction clutch, a spur-wheel change gear giving three speeds forward and one reverse, and a bevel drive to the live rear axle. [See also Abstracts Nos. 962 and 1213 (1902).] C. R. D'E.

153. *Toledo Touring Car.* (Horseless Age, 10. p. 201, Aug. 20, 1902.)—This is an American gasoline car, modelled closely on the lines of the Panhard cars. The engine is of the three-cylinder vertical type, and is mounted towards the front of the underframe. The power is transmitted through a cone friction clutch to a change gear, in which three forward speeds and one reverse are obtained by sliding spur gears. Bevel gearing is employed to transmit from the change gear counter-shaft to the differential cross-shaft, from which the road wheels are driven by independent chain gears. The cylinders of the engine are 4·25 in. bore × 5·25 in. stroke, and the pistons are coupled to cranks at 120°. The engine is controlled by a throttle governor. C. R. D'E.

154. *Fischer Gasoline-Electric Truck.* (Horseless Age, 10. pp. 221–222, Aug. 27, 1902.)—This is an electrically driven goods truck, in which the current is generated by a dynamo direct-coupled to a petrol engine. The engine has four cylinders, 5·5 in. bore × 6 in. stroke, and the dynamo generates 9 kw. at 110 volts and 550 r.p.m. The rear road wheels are driven independently by two 8-h.p. motors, and a battery of 44–136 ampere-hour cells is carried and kept charged by the dynamo to supply the necessary reserve of power for negotiating severe gradients. C. R. D'E.

155. *Hansen Gasoline Carriage.* (Horseless Age, 10. p. 223, Aug. 27, 1902.) —This vehicle is propelled by a single-cylinder horizontal engine, mounted

[1] Electric Automobiles are described in the Section dealing with Electric Traction.

Digitized by Google

beneath the carriage body. The cylinder is 4·5 in. bore × 5·75 in. stroke ; it is fitted with high-tension electric ignition, and a carburettor in which the petrol supply is regulated by a spring-controlled valve in the suction pipe. The changes of speed in the transmission are obtained by means of epicyclic gearing. A single roller chain transmits the power from the change-speed gear to the live near axle. C. R. D'E.

156. *Packard Transmission.* (Horseless Age, 10. pp. 187–189, Aug. 20, 1902.)—The transmission gear of the Packard gasoline carriages is described. Its special feature consists of a spring drive between the engine flywheel and the friction clutch, and an arrangement of spur pinions and wheels in the change gear which enables the driver to bring back the change-speed lever to the neutral point from any speed without passing through the intermediate gears. C. R. D'E.

REFERENCES.

157. *Modern Portable Engines.* **W. Fletcher.** (Feilden, 7. pp. 45–56, July, and 123–130, Aug., 1902.)—The author gives an illustrated description of some of the leading types of portable steam engines with multitubular boilers. G. W. DE T.

158. *Steam Turbines.* **S. E. Fedden.** (Electrician, 49. pp. 522–523, July 18; Discussion, pp. 588–591, Aug. 1, 1902. Paper read before the Municipal Electrical Association.)—In this paper the author advocates the use of steam turbines, in preference to reciprocating engines, as the prime movers in electric power stations. G. W. DE T.

159. *Engines for Large Electric Power Stations.* **A. A. Day.** (Electrician, 49. pp. 558–560, July 25; Discussion, pp. 588–591, Aug. 1, 1902.)—In this paper the author advocates the use for large stations of low-speed horizontal compound, or triple-expansion condensing engines, with the generators direct-connected between the cranks. He considers that the repairs to such an engine will be found to be reduced to a minimum if the valve gear is of the Corliss tripped type. G. W. DE T.

160. *Locke Steel Chain.* (Engineering, 74. pp. 243–244, Aug. 22, 1902.)—A description is given, with illustrations, of a machine which produces a finished driving chain with the links fastened together from strip steel fed into it. The chain is then hardened by being led through a gas-furnace and a tank of water; the tempering is done by immersing the whole reel of chain in a bath of hot oil. H. R. C.

161. *Automatic Lubricator.* (Engineering, 74. p. 355, Sept. 12, 1902.)—An apparatus for the continuous application of "Sinol," a semi-solid lubricant composed chiefly of graphite. H. R. C.

162. *Graphite Lubrication.* **A. Mulhoux.** (Locomotion Automobile, 9. pp. 567–568, Sept. 4, 1902.)—The advantages attending the use of graphite for the lubrication of internal-combustion engines are discussed, and an apparatus is described for feeding graphite and oil in constant proportions. [See also Abstract No. 31 (1903).] C. R. D'E.

163. *The Locomobile Car.* **Vétéran.** (France Automobile, 7. pp. 616–619, Sept. 27, 1902.)—The paper gives a complete description of the locomobile steam car with several good diagrams and photographs of the mechanism. [See also Abstract No. 547 (1902).] C. R. D'E.

Digitized by Google

INDUSTRIAL ELECTRO-CHEMISTRY AND GENERAL ELECTRICAL ENGINEERING.

164. *The Dessolle Process of Electroplating with Copper.* **H. Fontaine.** (Électricien, 23. pp. 170–174, Sept. 13, 1902. Report read before the Société d'Encouragement des Arts Economiques.)—The author of this report, after briefly referring to the methods of Oudry, Weill, Gauduin, and Wilde for obtaining electro-deposits of copper, passes on to a description of the Dessolle process, which is now in operation at the small works of Levallois-Perret in France, and at a works near Birmingham. The chief feature of the Dessolle process is the use of jets for guiding the electrolyte under pressure against the face of the electrodes. This invention enables one to use a very high-current density without endangering the adherence, smoothness, or density of the deposited copper. All solid particles and bubbles of gas are also swept away by the jets from the faces of the electrodes, and irregularities in the deposit of metal are thus avoided. The sheets or articles to be coated with copper by the Dessolle process are first cleaned, preferably by the dry method with sand, and are then immersed in a "striking" bath in order to obtain a preliminary coating or skin of copper. This bath contains double cyanide of potassium and copper, rendered slightly alkaline with ammonia. A current density of 80 amperes per square metre is employed in this bath. The articles are then withdrawn, washed, and any exposed spots or pin-holes are filled up with tin, either by use of a tin solder or of spongy tin.

The electroplating bath, into which they are next placed, is an acid solution of copper sulphate, and contains 12 parts crystallised $CuSO_4$ in 85 parts of water, with 3 parts of sulphuric acid. The jets fixed in this bath supply the electrolyte to the electrodes under pressure, a storage tank placed 5 m. above the ground, acting as feeder to the bath, and the liquid being kept in constant circulation by aid of pumps with wooden rams. Under normal conditions of work in electroplating baths, only a thickness of 10 mm. of copper is deposited in 100 hours. With the Dessolle process it is practicable to use a current density of 750 amperes, and to obtain an excellent deposit of copper 1 mm. in thickness, in the comparatively short space of 15 hours. The baths are heated to a temperature of 35° C. during deposition of the copper, a system of heating tubes being employed in the interior of the depositing vats. At Levallois-Perret the plant comprises depositing vats measuring 6·2 m. in length by 2·50 m. in breadth and 1·50 m. in depth, and castings up to 5 tons in weight can be electroplated. The electrical and mechanical power is supplied by a 100-h.p. steam engine. The generating plant consists of a large number of dynamos, the largest being a machine generating 4,000 amperes at 3 volts. The charge for plating steel sheets with copper on both sides is 3·75 francs per square metre for a deposit 0·02 mm. in thickness, and 20 francs per square metre for a deposit 0·2 mm. in thickness. This corresponds approximately to 5 francs per kg. The application for which this method will probably be found most useful, is for the internal coating of steel tubes intended for steam pipes on naval vessels. Copper tubes and pipes lack strength, and steel tubes covered internally with copper will prove a most satisfactory substitute for them.

J. B. C. K.

Digitized by Google

165. *Electrical Manufacture of Glass.* (Elektrotekn. Tidsskr., Christiana, 15. p. 177, Oct. 6, 1902.)—The method depends on the capacity of glass to conduct electricity in the molten state. To start the process, a certain amount of material is fused in any convenient manner. An alternate current is then made to traverse the molten mass, either single-phase or polyphase. A convenient amount of material is next added, which, by the heat derived from the overheated glass, will be melted into glass. The fluid glass produced may gradually be drawn off, provided care be taken to leave an amount sufficient to conduct the current. The process may be made a perfectly continuous one. A. G.

166. *Magnetic Separation of Zinc Blende at Denver, Colorado.* (Eng. and Mining Journ. 74. p. 217, Aug. 16, 1902.)—A brief description of the separation of a blende product from a pyrites product, the former suitable for zinc smelters, the latter for lead smelters. The division is made by Wetherill magnetic machines, and is possible because the pyrites product contains ferrous sulphide. Forty to 50 tons of ore are treated per day LL. B. A.

167. *Fixation of Atmospheric Nitrogen.* (Elect. World and Engineer, 40. pp. 159–161, Aug. 2, 1902.)—The Atmospheric Products Company now has a plant in operation at Niagara Falls for the manufacture of nitric acid, in which the requisite nitrogen is obtained from the atmosphere. The method employed is the outcome of some years of experimental work on the part of C. S. Bradley, and B. R. Lovejoy. The investigation directed itself naturally to the production of a large number of arcs in a confined space traversed by a constant stream of air. It was soon found that a static spark was not very effective. Alternating- and direct-current arcs of various voltages were tried, and the best results were obtained by making and breaking in rapid succession a large number of 10,000-volt direct-current arcs. The current is supplied from a large direct-current series arc machine, having separately excited fields. The spark terminals are connected in parallel with those of the dynamo, and to prevent the arc from short-circuiting the machine, an inductance coil is placed in series with each of the spark-gaps. The sparking device consists of a metal box provided with openings to admit the air and properly circulate it, and containing rows of fixed contacts. Each of these contacts is insulated with great care, and to each is connected a wire passing first to an inductance and thence to the positive pole of the dynamo. The negative pole is a revolving cylinder equipped with properly spaced projections which come very near, but do not touch, the fixed contacts in the surrounding box. This cylinder is driven by a vertical electric motor at 500 r.p.m.; and as there are six sets of contacts in line with the fixed contact on the wall of the cylinder, each fixed contact therefore provides 3,000 arcs per minute. The air is driven through the apparatus at the rate of about 5 cub. ft. per arc contact per hour. In the apparatus now in use there are 138 contacts, six rows of 23 each. The exact voltage, the correct amount of inductance, the number of breaks per minute, the arrangement of the contacts with reference to the air circulation, and last, but not least, the proper state of the arc, are matters which involved much careful investigation. The air emerging from the apparatus contains about 2¼ per cent. of oxides of nitrogen, which are converted into nitric acid by passing them through water contained in sprinkling towers, or into nitrates by passing them through caustic alkali. G. W. DE T.

Digitized by Google

168. *Nozzles for High-pressure Water Turbines.* **W. S. Smith.** (Journal of Electricity, S.F. 12. pp. 155 and 158, Aug., 1902.)—At the recent Convention of the Pacific Coast Transmission Association, Eastwood exhibited some pitted specimens of discharge nozzles which had been in use under high heads of water in Pacific Coast transmission plants. This pitting he attributed to the cutting action of eddies formed in the nozzle. The author argues that it is due to the chemical action of oxygen collecting at points at which the pressure is a minimum, owing to the defective design of the nozzle. He cites an instance of cutting which occurred shortly after the erection of a plant, and which he considers was due to sand and grit still remaining in the pipe. He observes that it is very common to design these nozzles without regard to the stream lines. The diameter of discharge must of course be calculated so as to deliver sufficient water to develope the desired amount of power, and the diameter of the base of the conical part may be assumed; all other dimensions must be determined by experiment. A properly designed nozzle will not pit, and a nozzle which does pit will always discharge an inefficient stream. A nozzle having the proper form for a given velocity of discharge will not be exactly right for another velocity, such as would be obtained by throttling down, for the position and diameter of the contracted vein will vary with the velocity. A nozzle which will fill at the highest velocity of flow, will, however, continue to fill at lower velocities, owing to the fact that the contracted vein will shift backwards and increase in diameter, instead of being pushed forwards and diminishing in diameter. G. W. DE T.

169. *Electro-hydraulic Balance.* **W. Hentze.** (Zeitschr. Elektrotechn., Wien, 20. pp. 858–859, July 20, 1902.)—This describes a new apparatus designed by Herr Hentze for the measurement of the flow of water and pipes. A solenoid through which an alternating current is passed, is fixed axially within the pipe and is provided with a movable iron core to which a disc is attached. The water pressure acting on this disc forces the core into the solenoid against the electromagnetic repulsion of the current. The impressed voltage is maintained constant so that for each rate of flow the core comes to a definite position of equilibrium. In order to obtain quantitative readings a wattmeter or ammeter is provided by means of which the choking effect on the current in the solenoid for different positions of the core may be observed. The apparatus is illustrated diagrammatically and a curve is given showing readings obtained on a trial instrument. J. G.

170. *The Milammeter and Galvanometer for Cable Testing.* **C. W. Schaefer.** (Electrician, 49. pp. 677–679, Aug. 15; 707–709, Aug. 22; 755–757, Aug. 29; and pp. 793–795, Sept. 5, 1902.)—The four articles give the author's views and experiences in the uses and advantages of the milammeter, as a substitute for the mirror galvanometer in a variety of practical cases, but chiefly in connection with the testing of submarine cables. In each case he gives the necessary formula and generally an arithmetical example. Without following his precise order, it may be stated that he gives suggestions for ascertaining the conditions, which a good milammeter must fulfil. He shows how an ordinary galvanometer, in which the deflections are proportional to the currents passing through it, may be used as a milammeter. He points out the way to find the e.m.f. of a polarisable battery and how to use the instrument as a direct reading voltmeter. In dealing with the milammeter as a means of ascertaining resistances, he explains not only how to measure simple resistance, but also the copper resistance of a cable; the internal resistance of a

Digitized by Google

battery of known e.m.f. and its effective p.d.; the internal resistance of a standard cell; the leakage resistance and resultant position thereof in a testing battery; the resistance of earths, galvanometers, and their constants. A. J.

171. *Brake Tests.* **P. Jobst.** (Elektrotechn. Zeitschr. 28. pp. 680–681, July 17, 1902.)—The various sources of error in brake tests are discussed, these being mainly due to the difficulty of obtaining absolute simultaneity in the readings of speed, volts, amperes, and of the brake balance. If a counter instead of a tachometer is used, there is further error due to variations during the period during which the revolutions are counted. The author prefers to use Siemens and Halske's tachometer consisting of a small dynamo separately excited to saturation, or better, to avoid errors from the commutator, a small alternator with revolving permanent magnet. The speed is then read by means of a suitable voltmeter, which can be mounted on board with the other instruments. By arranging the spring balance of the brake in the plane of this board and illuminating the whole with a strong light, a photographic record can be obtained ensuring absolute simultaneity of all readings and eliminating personal errors. By mounting the calibration curves or tables of all the instruments on the same board the record of the test is complete and is available for reference at any time. With facilities for rapidly changing the photographic plates, as many as twelve sets of readings have been taken in two minutes. A. E. L.

172. *Gola's Lightning Arresters.* (Elektrotechn. Zeitschr. 28. pp. 455–457, May 22, 1902. From a paper read by **G. Gola** before the Associazione Elettrotecnica Italiana in Milan.)—The principle of Gola's arrester is to so arrange a magnetic field as to prevent a discharge passing through the arrester along the line, and direct it into the path it should take to earth, across a spark-gap. The arrester consists of two semi-ellipsoidal shells of iron, fastened together by bolts, with a ring of zinc interposed. Covering the upper half is another iron shell separated from it by an air-space, but in metallic contact through bolts. This covering shell and the lower shell form the pole-pieces of an electromagnet, so that there is a magnetic field in the air-space between the covering shell and the upper shell, and in the zinc ring between the upper and lower shells. Opposite the two ends of the major axis of the ellipsoid are two carbon poles, fixed in independent insulators and connected to earth. Between these and the ellipsoid is the spark-gap. The outside conductor is attached to the upper shell and its covering shell, and connection is made from inside of the zinc ring by a terminal passing through the lower shell and insulated from it. From this the current goes through the electromagnet and to the apparatus to be protected. The magnetic field across the zinc ring makes the passage of a lightning discharge through it very difficult, and, further, the magnetic field between the upper shell and its covering directs the discharge to the ends of the major axis of the ellipsoid, and forces it to take the path through the spark-gaps instead of through the zinc ring. This action enables the spark-gaps to be made twice as long as in other arresters, and does away with the necessity of any mechanical arc-rupturing device. The arresters have been tried on a line supplying power in the Apuanian Alps, in a situation peculiarly susceptible to discharges. From October, 1900, to May, 1901, the line which was protected by horn arresters, was struck four times, and the machines damaged. Since that date, when two Gola arresters were installed, no lightning discharge has reached the station. G. H. B.

Digitized by Google

173. *Lightning and other High-pressure Discharges.* **P. H. Thomas.** (Canad. Elect. News, 12. pp. 148–152, Aug., 1902. Paper read before the Canadian Electrical Association Convention, Quebec, June, 1902.)—The author discusses injuries to electrical apparatus caused by lightning, either in going to earth or in jumping across inductive coils, and points out that severe stresses on the insulation may be induced by the sudden drop of potential in a coil when a lightning discharge is carried to earth by an arrester. Apart from lightning discharges, violent stresses may also be brought about by grounds or short-circuits, charging a dead line or transformer, disconnecting a lightly loaded transmission line, &c., and the author recommends the use of a choking coil connected to earth through a condenser (the connection being between the coil and the apparatus to be protected) as an effective safeguard against this danger. A comparatively small coil, under these conditions, adequately protects the apparatus against stresses due to surging in the line or in the winding, but an arrester is necessary in addition to provide against stresses between the line and earth, as in the case of lightning. [See also Abstract No. 2158 (1902).] A. H. A.

174. *Worm Gearing.* **N. Westberg.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 915–920, June 21, 1902.)—This paper describes tests which were undertaken by the Oerlikon Company with a view to testing the efficiency of their worm gears. The method employed consisted in connecting a 400-volt polyphase motor of 35 h.p., running at 780 r.p.m., to the worm gearing, the worm wheel being directly connected to a pulley, over which a belt was passed to drive a dynamo. The various losses in the motor and dynamo were first ascertained at all loads, and then by running the combination under varying loads, and making an allowance for the loss in the belting, the efficiency of the worm gearing was determined. Figures are given showing the results obtained with a worm having five threads, the gearing working in an oil-bath, and having a velocity ratio of 5 to 68. Full load was supposed to be about 25 h.p.; when transmitting 22 h.p. the efficiency of the worm gearing was 94·9 per cent.; at 32 h.p., 94·5 per cent.; at 37 h.p., 91·3 per cent. Comparing these figures with the known theoretical value of the efficiency of such gears, the coefficient of friction appears to be 0·01, this low value being due to the thin film of oil which comes between the metal surfaces. A table is given showing the theoretical efficiencies of worm gearing with varying coefficients of friction, and with threads having different angles of inclination. These are also graphically treated. The coefficient of friction is a matter of the greatest importance; but by increasing the inclination of the thread beyond 25° no great improvement in the efficiency results. The above-mentioned worm gearing was also tested for four hours at full load, and the temperature of the oil-bath rose 54° C. With a better arrangement for the circulation of the oil this figure could no doubt be reduced. The use of motors driven by worm gearing is largely adopted by the Oerlikon Company, and is likely to be extended. W. H. S.

175. *Power Consumption of Electric Elevators.* (Amer. Inst. Elect. Engin., Trans. 19. pp. 978–1005, June and July, 1902.) Discussion of paper by G. F. Sever. [See Abstract No. 51 (1903).]—**C. Steinmetz** regretted that the author had not distinguished between the rheostatically controlled alternate-current motor and the one with no controller. They were essentially distinct types, and the former being a high torque acceleration motor, was especially suitable for elevator work, although the latter was the one in most general use for this

Digitized by Google

purpose in New York. **A. V. Abbott** drew attention to the different character of the load curves for office and apartment house electric elevators respectively. He pointed out that for the latter work rapid acceleration was not requisite, and here the determining factor was the invariable absence of skilled attendance, so that when the cost of maintaining the commutators, and of other repairs, was taken into account, the expense on the alternate-current system would prove to be less. G. W. DE T.

176. *Electricity in Iron and Steel Works.* **F. Kylberg.** (Iron and Steel Inst., Journ. pp. 2–16, Sept., 1902.)—The author first refers to the successful use at the Differdingen Ironworks and at the Düdelingen Eisenhütten-Aktien-verein in Luxemburg of waste blast-furnace gases for driving gas engines for generating electric power. He then describes with drawings a number of different kinds of electrical appliances employed at different steel works. An interesting procedure is that described by the author as used in American steel works for saving time and labour in casting the steel "blooms." An electric crane lifts the casting ladle over a train of small cars containing the ingot moulds, and, as each mould is filled, an electric adjusting gear brings the next car with its mould under the crane, thus avoiding any moving of the crane with its enormous mass of molten metal. Great force is required in "stripping" or drawing the "blooms" out of the moulds, and formerly hydraulic power was invariably employed for the purpose, but in the Bethlehem Steel Works an electro motor-driven screw press is employed, which greatly accelerates the process, while at the same time effecting a considerable economy of power. The same crane then lowers the ingots into the "soaking pits," in which the outer portion of the ingots is kept hot until the inside portion has had time to solidify, when they are ready for the rolling mill. The introduction of electric driving for the rolling mill accessory apparatus not only effects a great economy in comparison to the hydraulic methods formerly employed, but has rendered possible the use of automatic means of maintaining the thickness constant. This is a matter of the greatest importance in the case of tyres and many other rolled products. With the hydraulic system, hand regulation, depending on the workman's sense of touch, had to be relied upon. The chief difficulty in maintaining the right pressure lies in the uneven temperature of the ingot, which tends to cause a greater reduction in the thickness of the hotter portions of the "bloom." G. W. DE T.

177. *Electric Power in Iron and Steel Works.* **A. Abraham.** (Génie Civil, 41. pp. 277–282, Aug. 30, 1902.)—The author describes with illustrations various electrical appliances employed in iron and steel works, including the electric machinery used for the transport of steel "blooms." He states that, in addition to using electric driving for all accessory rolling mill purposes, which has been done in various ironworks, the steel works at Anvers are using it for the driving of the rolls themselves in the case of all but the very largest rolls. G. W. DE T.

178. *Electric Power in the Iron and Steel Industries.* **D. Selby-Bigge.** (Iron and Steel Inst., Journ. pp. 3–32, Sept., 1902.)—This paper deals mainly with figures showing the economy effected by driving electrically the machinery employed in iron and steel works, and machines of a similar character elsewhere. Striking examples of this are given in the case of the quayside cranes at Hamburg, where the introduction of electric power in the place of

Digitized by Google

steam reduced the cost per ton lifted from nearly 2¾d. to just under a penny. In a Northumberland colliery an electric plant costing £8,000 was used to replace steam for driving seven pumps, each delivering about 100 gallons a minute, and was found to effect an annual saving of over £1,500. In the Ewald Colliery, in Germany, the replacement of horse haulage by electric reduced the cost by about one-half, after allowing for interest and depreciation.
G. W. DE T.

179. *Electric Installations for Drainage of Mines.* **J. A. Montpellier.** (Électricien, 23. pp. 161–170, Sept. 13, 1902.)—The paper gives a detailed description of a pumping plant in the Monterrad pits of the Roche-la-Moliers and Firminy Mining Company. The plant is three-phase by Oerlikon. A horizontal engine of 300 h.p. drives an inductor alternator giving 1,000 volts, and with a frequency of 20. A three-phase motor giving 200 h.p. at 100 r.p.m. is coupled direct by a flexible coupling to a double-acting pump with cranks at 120°, fitted with air vessels, and with an air pump to keep these full. The special feature of the installation is that the pit being gassy, the motor has a closed circuit winding without slip rings, and no switches are provided underground, and to start the plant, the generator is fully excited and then started slowly, and takes the pump motor gradually up to speed with it, the starting current hardly exceeding the full load starting-current. The motor starts with the full load on. The description is fully illustrated.
LL. B. A.

180. *Electric Pumping from a 1,300-foot Level.* **D. H. Fry.** (Journal of Electricity, S.F. 12. pp. 110–111, June, 1902.)—The author describes with illustration a pump draining the Oneida Mine, Amador County, U.S.A. The pump is a three-throw, double-acting plunger pump driven by gearing by a 100-h.p. Westinghouse, three-phase induction motor. The chief points of interest are the arrangement of valves and byepasses to allow the motor to start without the load of the column of water, and then to gradually take up this load. To compensate for the uneven flow from the pumps, piston chambers with springs are provided instead of air vessels, which, at such lifts, are useless. The pump delivers 197 galls. per minute against a head of 1,295 ft.; the efficiency of motor and pump is 65·75 per cent. LL. B. A.

181. *Electric Drainage of Mines.* **J. Goffin.** (Soc. Belge. Elect., Bull. 19. pp. 345–382; Discussion, pp. 382–389, June, 1902.)—A full description is given of methods for electric pumping, and specially of modern pumps suitable for direct connection to electric motors for running at high speeds. The pumps described are those of the Jandin system, where, with two plungers and cranks at 120°, the maximum variation of flow is only 0·014 of the volume of the piston. This is explained by diagrams. These pumps have been made to run at 450 r.p.m. The Riedler pump with mechanically operated valves is then described, also the systems of Ehrdardt and Schmer and Hoppe. In the discussion which followed this paper, **M. Kersten** advocated hydraulic pumps in preference to electric, owing to the possibility of working them when drowned, but this was shown to be such a rare occurrence as to be negligible.
LL. B. A.

182. *Winding from Great Depths.* **C. Frerichs.** (Soc. Belge. Elect., Bull. 19. pp. 390–432, June, 1902.)—This paper is a study of the problem of winding engines, and methods of winding from great depths. The steam

Digitized by Google

engine is almost the sole means now employed, but from the point of view of economy leaves much to be desired. The consumption of *fuel* per h.p.-hour developed is given as 26 lbs., corresponding to, say, 260 lbs. of steam. Other writers calculate at least 170 lbs. of steam per h.p.-hour. This may be improved by 80 per cent. by the use of automatic apparatus, varying the cut-off as the winding proceeds. Electric motors have so far not been used except for moderate powers, say up to 400 h.p., and the writer questions whether they ever will compete successfully where so much starting and stopping has to be done. The paper gives a discussion of the methods of equalising the load by conical drums, &c., and ends by a description of the winding plant at the East Rand Proprietary Mines with an engine (double-cylinder tandem) of 1,100 h.p., 220 lbs. initial pressure. LL. B. A.

183. *Electric Mine-draining Plant at the Düsseldorf Exhibition.* (Engineering, 74. p. 57, July 11, 1902.)—This paper contains an illustrated description of a pumping plant constructed by Messrs. Haniel and Lueg, Düsseldorf-Grafenberg, with a Lahmeyer generator and motor. The pump has a 650-h.p. motor, and will lift 1,210 galls. per minute 1,476 ft. head. The motor is a three-phase induction motor working at 2,000 volts, and drives the pump direct at 60 r.p.m. At starting, by an automatic contrivance, the pump acts as an engine with the water column ; when 20 r.p.m. is reached the current is switched on. The three-phase dynamo is excited by a three-phase to continuous converter, and by accumulators at starting, which are recharged from the converter. LL. B. A.

184. *Mine-draining Pump.* (Engineering, 74. pp. 108–109, July 25, 1902.)—The firm of Haniel and Lueg, Düsseldorf, showed at the Düsseldorf Exhibition a triple expansion steam pump of 3,600 i.h.p., capable of lifting 5,500 galls. per minute to a height of 1,646 ft. The design is unusual, as the whole plant had to be kept within 26·3 in. in width. The working pressure is 170 lbs., and the steam consumption 12·75 lbs. per i.h.p.-hour, and 15 lbs. per h.p. at the pump. Full drawings of this important pump are given.

LL. B. A.

REFERENCES.

185. *Education of the Electrical Engineer.* **H. W. Buck.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 781–784, May, 1902.)

186. *Electric Cement-making Plant.* (Elect. World and Engineer, 40. pp. 81–84, July 19, 1902.)—This paper describes the plant recently installed at the Portland Cement Works at Aken, New York, and furnishes a good example of the adaptability of electric power to meet the severe requirements of cement-making machinery.

G. W. DE T.

187. *Electrochemical Industries.* **S. Sheldon.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 791–804, June and July, 1902.)—In this paper the author briefly reviews the principal electrochemical manufacturing processes which are at present in commercial use. G. W. DE T.

188. *The Electric Furnace in Industrial Chemistry.* **C. B. Jacobs.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 805–817, June and July, 1902.)—The author, after recapitulating the three general types of electrical furnace, discusses some of their more important recent applications, and suggests some directions in which research is desirable. G. W. DE T.

Digitized by Google

GENERATORS, MOTORS, AND TRANSFORMERS.

189. *Design of Special Types of Generators.* (Elektrotechn. Zeitschr. 23. pp. 681–683, July 31, 1902. Paper read before the Elektrotechn. Verein, May 27, 1902. Discussion on Niethammer's paper. [See Abstract No. 1968 (1902)].)—**Bauch** gave an example of an impossible construction, although the electrical and magnetic data of the machine were quite normal; the impossibility was due to the enormous length of field coil. **Görges,** on behalf of **Kübler,** drew attention to the results of comparative tests with continuous-current and three-phase motors, working under identical conditions, on the new overhead line in Chicago, equipped by the General Electric Company. The following table shows the results obtained :—

	Full speed, 23 miles per hour.		Full speed, 24 miles per hour.	
	Watt-hours per ton.	Time taken to reach full speed.	Watt-hours per ton.	Time taken to reach full speed.
Continuous-current motors...	34·7	30 secs.	39·5	37 secs.
Three-phase motors.....	41·5	28 „	45·1	30 „

This is in contradiction to the author's statement regarding the accelerating capacity of continuous-current motors. **R. Braun** maintained that there was no difficulty about the design of high-frequency converters. He gave the following formula for the number of poles to be adopted in converters whose frequency is from 50 ∿ to 60 ∿ per sec., and whose output is between 50 and 500 kw.: Number of poles $= 6 + (\text{kw.} - 50)/37$. The peripheral velocity of the commutator may be as high as 20 to 25 m. per sec. He considered that the danger of hunting due to the use of long leads of comparatively high resistance had been exaggerated; the use of damping coils would in any case meet this difficulty. In his reply, **Niethammer** questioned the superiority of the induction over the continuous-current motor for rapid acceleration. He preferred using solid pole-pieces instead of damping-coils, regarding them as more effective; and in connection with rotary converters, mentioned a case in which one of these machines when fed through a cable of small cross-section hunted badly, whereas it ran quite smoothly when a larger cable was substituted for the small one. A. H.

190. *Theory of Commutation.* **K. Pichelmayer.** (Elektrotechn. Zeitschr. 23. pp. 623–624, July 17, 1902.)—This is a communication supplementary to the author's previous paper on the subject [see Abstract No. 188 (1902).] The reactance voltage E may be calculated by means of the formula, $E = 2\zeta n v A L_a . 10^{-8}$, where ζ = the flux linked with an armature conductor, per cm. length of core; n = turns per coil; v = peripheral speed, in cm. per sec.; A = flow of current per cm. length of armature circumference; L_a = length of core in cm. The value of ζ ranges in different machines from 6 to 9 c.g.s. lines per cm. length of core. A. H.

Digitized by Google

191. *The Heating of Toothed-Core Armatures.* **F. W. Davies.** (Electrician, 49. pp. 834–835, Sept. 12, 1902.)—The author points out that the high periodicity involved by the use of a large number of magnet poles in a small machine, may make the hysteresis and eddy-current losses amount to from 25 to 50 per cent. of the total armature losses, and that to use a four-pole magnet instead of a two-pole makes an appreciable difference in the permissible output.

R. B. R.

192. *The Specific Utilisation of Materials in Dynamo Design.* **S. P. Thompson.** (Electrician, 49. p. 879, Sept. 19, 1902. Paper read before Section G of the British Association.)—The author refers to the conception of the "active belt," meaning the entire mass of the peripheral structure of the armature down to the roots of the armature teeth, consisting of iron, copper, and insulation, introduced by Mavor at the Glasgow Engineering Congress, 1901 [see Abstract No. 974 (1902)]. He points out that we may extend the conception of the active belt, and consider the number of amperes that traverse each square inch of it parallel to the shaft, the mean number of magnetic lines that traverse each square inch radially, and the speed with which it moves forward tangentially. There are here three items that enter into the expression for the power per cubic inch, in three directions mutually at right angles to one another. He shows that if α = gross current density per square inch of active belt, β = gross magnetic density per square inch, $\gamma = \frac{v}{10^8}$ = a quantity proportional to the peripheral velocity, then $\alpha\beta\gamma$ = watts per cubic inch of active belt. The author has made a detailed analysis of fifty modern continuous-current generators of sizes above 50 kw. with slotted armature cores. He finds the values of α lie mostly between 300 and 460 amperes per square inch, the values of β mostly between 30,000 and 45,000, the extreme values being 22,000 and 58,000, the values of γ between 0·000004 and 0·000009, or 2,000 to 4,500 ft. per minute. In the machines considered the watts per cubic inch of active belt vary from 45 to 120, but in one case the value is as low as 15, and in another as high as 192. This last is the 1,600-kw. generator described by Mr. Hobart at the Engineering Congress at Glasgow. A high peripheral speed and high degree of saturation in the iron teeth conspire to give this machine a remarkably great output in proportion to its size.

R. B. R.

193. *Flywheel Dynamo.* **K. Nowak.** (Elektrotechn. Zeitschr. 23. pp. 631–633, July 17, 1902.)—A continuous-current machine to give 650 kw. at 90 r.p.m. which has been designed of such dimensions as to require no separate flywheel in order to obtain a degree of uniformity of 1 : 200 with a single-crank tandem engine. The armature is 5 m. in diameter and 210 mm. wide, with 505 slots each 16 × 42 mm. The commutator, 3 m. in diameter, has 1,010 segments. The weight of the armature and commutator is 48 tons.

A. E. L.

194. *Frames of Alternators.* **H. Böhmländer.** (Elektrotechn. Zeitschr. 23. pp. 659–660, July 24, 1902. Paper read before the Elektrotechn. Verein, May 25, 1902.)—Siemens and Halske have adopted built-up wrought-iron frames for the armatures of large alternators. The necessary stiffness can be secured with a weight about equal to that of the active materials instead of about five times as in the case of cast-iron frames. Instead of clamping the laminated iron between flanges forming part of the main frame, it is clamped

Digitized by Google

up with angle-iron rings, which are attached to the frame by adjusting bolts, allowing an exact adjustment to a perfectly circular form. The construction also admits of freer ventilation. A. E. L.

195. *Monophase Synchronous Motors.* **G. Markovitch.** (Assoc. Ing. Él. Liège, Bull. 2. pp. 270–331, March–April–May, 1902.)—This is an exhaustive theoretical treatment of synchronous motors. Graphical methods are for the most part employed, though the author occasionally resorts to analytical treatment. The following conclusions are arrived at: (1) The construction of synchronous motors is identical with that of alternators, and the armatures can be directly supplied with current at high pressure. (2) Synchronous motors whose armatures are supplied with monophase or polyphase currents must have their field magnets excited by continuous currents. (3) Synchronous motors are not self-starting even on light load; they must be brought to approximately synchronous speed by auxiliary apparatus. (4) Before throwing synchronous motors into circuit the voltage, speed, and phase should be recorded by a voltmeter and phase indicator, to ensure that they agree with the source. (5) When stopping synchronous motors the alternating current should be cut off before breaking the exciting circuit. (6) For any given load the current taken from the source of supply depends upon the excitation and should be adjusted to make the power-factor unity. If this be done the current taken on light load will only be from 10 to 15 per cent. of that required for full load. (7) The maximum power which can be exerted by a synchronous motor is practically limited by the heating of the armature, and by the fact that at some loads the machine will fall out of step and stop. (8) The speed of a synchronous motor is independent of the load. (9) To change the direction of rotation of a synchronous motor, it must first be stopped and started again in the opposite direction. (10) A synchronous motor can be employed as a regulator of an alternating-current supply system. An over-excited synchronous motor has a capacity effect on the circuit. (11) When a synchronous motor is mechanically driven it can be used as an alternating-current generator. (12) The choice of a synchronous motor depends upon the purpose for which it is to be employed and upon the source of supply. W. G. R.

196. *Effect of Closed Slots in Stator Cores of Induction Motors.* **W. Mollier.** (Elektrotechn. Zeitschr. 23. pp. 670–673, July 31, 1902.)—The author gives an account of some experiments on the effect of converting the closed tunnels of a stator core into open ones—which is the general present-day practice. The effects produced by opening the slots may be briefly summarised as follows: The magnetising current is increased on account of the increase in the reluctance of the leakage paths; for any given load, the stator current is larger, the overload capacity greater, and the slip less, than in a stator with closed tunnels; the power-factor is at light loads less, but at heavy loads higher, than with closed tunnels. The author's experiments show that an extremely narrow air-gap—say 0·3 mm.—cut through the bridge-pieces of the slots is sufficient to produce very marked effects. A. H.

REFERENCE.

197. *Armature Windings.* **W. Kübler.** (Elektrotechn. Zeitschr. 23. pp. 633–634, July 17, 1902.)—A description of a new method of representing armature windings by means of tables. A. E. L.

Digitized by Google

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

198. *Protection of Electric Transmission Lines against Lightning.* **Dussaugey.** (Soc. Int. Élect., Bull. 2. pp. 633–658, Aug., Sept., and Oct., 1902.)—This paper contains a discussion of the principles involved in the design and application of lightning arresters for the protection of electric transmission lines. The various arresters at present in use are dealt with, and attention is called to a new form of arrester, designed by the author, which has been in actual operation for some time with very satisfactory results on the transmission line between Voiron and Grenoble, France. The apparatus was designed to dispense with the costly reactances which are usually placed in series with the arrester-gap and earth. The author finds that sufficient reactance can be obtained by forming sharp angle bends in the line conductor round insulators on the lightning arrester supports. The arrester consists simply of a pair of curved horns attached to the line conductor. The earth connection is made with a vertical rod which is situated in the middle of the gap between the horns.

The author discusses fully the precautions to be taken in distributing arresters over a transmission system, and points out the necessity for periodical rigorous inspection of all the apparatus if reliability in operation is to be expected. He concludes the paper by suggesting that, in view of the limited experience in the protection of long-distance transmission schemes, some concerted action on the part of European engineers in charge of such schemes should be taken, with the object of obtaining accurate information from systematic series of extended observations, of the atmospheric and other conditions affecting the operation of arresters. The paper is accompanied by diagrammatic illustrations of a number of different forms of arrester apparatus. J. G.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

199. *Electricity Works at Ludwigshafen on the Rhine.* **R. Gassner.** (Elektrotechn. Zeitschr. 23. pp. 647–650, July 24, 1902.)—This station contains three 400-h.p. polyphase generators, driven by single-crank engines at 94 r.p.m. The voltage of 3,000 is transformed to 125 for distribution purposes. A drawing is given, showing the general arrangements. W. H. S.

200. *Power Transmission in the Department of the Aude, France.* (Ind. Élect. 11. pp. 413–425, Sept. 25, 1902.)—The power station is on the Aude at Saint-Georges. It utilises a fall of 100 m. The plant includes four three-phase Alioth alternators, coupled to Pelton wheels, running at 300 r.p.m. The output of each is 540 kw. at 2,900 volts and 50 cycles. The pressure is raised by transformers to 20,000 volts. The main feeder is to Fabrezan, 70 km. distant, and from this point other feeders go to outlying points, the longest at present being 35 km. long. On the 70-km. feeder a loss of 20 per cent. is allowed at full load. It is composed of three cables, each of 38 sq. mm. sec-

Digitized by Google

tional area, placed at distances of 60 cm. from one another. All the insulators were tested at 40,000 volts, but in spite of this, some broke down after a short time under working conditions. A faulty insulator is easily detected owing to the fact of its glowing in the dark when under pressure. Distribution is generally effected by alternate current at 125 or 150 volts, but in some cases continuous current at 300 volts is supplied through synchronous motor generators. The undertakers have built the station and provided the high-tension transmission lines. All the rest of the work has been done at the expense of the various towns and of private persons. The lighting of the towns is therefore carried out without charge at the rate of twenty-five 16-c.p. lamps per 1,000 inhabitants. For private persons the charge for lighting is at the rate of 32 francs per 16-c.p. lamp per year. The price for motive power is not stated, but the motors are supposed to be stopped during the hours of the lighting load. W. H. S.

201. *Kendal Electric Lighting.* (Elect. Engin. 30. pp. 330–333, Sept. 5, 1902.)—The Kendal lighting station contains two single flue dry-back boilers by Fraser and Sons, Millwall, for a duty of 2,500 lbs. of steam per hour each. Hayward Tyler duplex feed pump with an electrically driven auxiliary pump are provided. The feed water is heated by the exhaust in a Berryman heater. There are two Willans engines driving 86-kw. Johnson and Phillip's dynamos at 400 revolutions. The dynamo voltage is 450, and a balancer-booster set is provided, consisting of four machines coupled together. There is a battery of 240 L.A. 7 Tudor cells. The three-core, clover-leaf mains were supplied by the British Insulated Wire Company, and are laid in troughs filled in with compound. They are 0·15, 0·08 and 0·15 sq. in. in section, with branches of 0·1 and 0·05. A. E. L.

202. *Sunderland Corporation Electricity Works.* (Electrician, 49. pp. 779–784, Sept. 5, 1902.)—The new generating station in Sunderland is erected on a site which permits of extensions up to an ultimate output of 20,000 h.p. Water is obtained from deep wells by means of an Isler's pump, having an output of 5,000 gallons an hour. The present instalment of buildings is designed to hold machinery for 5,000 h.p., and consists of a boiler-house 169 ft. by 63 ft., and engine-room 169 ft. by 43 ft., and battery-room 71 ft. by 24 ft., together with fitting and joiner's shops, &c., superintendent's house, and foreman engineer's and electrician's houses. The general arrangement is shown in plan. The boiler-house is designed to take eight Lancashire boilers, 28 ft. by 8 ft. 6 in., of which five are at present installed. The working pressure is 160 lbs. An unusual method of covering in the boilers has been adopted. The partition wall between each pair of boilers is built higher than the top of the boiler shell. The shell is covered with blue asbestos mats, and a chequer plate floor is laid on light tee frames supported by the partition walls. "Triumph" mechanical stokers are fitted, of which descriptions and illustrations are given. In a twelve-hours' evaporation test, of which details are given, the results were 8·9 lbs. of water from and at 212° F. per lb. of fuel, the fuel used being South Hetton unscreened bean small. Above the pump-rooms are fixed two storage tanks, each having a capacity of 8,000 gallons, where the water is softened by the Archbut-Deeley process. The feed water passes through a Harris-Anderson purifier. An illustration of the "Solutioner" is given. A lengthy description of the softening process is given, together with illustrations of the apparatus. The main steam pipes are of 6 in. diameter welded steel, with copper bends, and are

Digitized by Google

fitted with steam driers and traps. All pipe work is in the boiler-house, carried on a light steel platform, only the branch pipes to the engines being taken into the engine-room. The engine-room equipment consists of two 125-kw. Silvertown-Bellis triple-expansion sets, three ditto of 500 h.p., with provision for two 700-kw. sets, which will be the standard for future extensions. The circulating water for the condensers is taken from a cooling pond, on which is mounted a Klein natural draught cooling tower. The switchboard is described and illustrated. The battery consists of 180 Tudor cells, having an output of 1,680 ampere-hours. It is the intention to shortly erect substations in the shipyard district, containing three-phase motor generators run from a 5,500-volt circuit. Four 750-kw. three-phase, star-wound alternators, wound for the above pressure at 50 ∿, will be added to the station, and the pioneer station in Dunning Street converted into a sub-station. F. B.

203. *Electric Plant at Blaenau, Festiniog.* (Elect. Rev. 51. pp. 488–485, Sept. 12, 1902.)—Power is transmitted from the Falls of Dolwen, where the head of water is 200 ft. Pelton wheels are used, direct-coupled to dynamos, which generate the transmission current at 560 volts. The present plant consists of two 90-kw. machines and a battery of accumulators. The power is mainly used in the slate quarries, and also in the town of Blaenau Festiniog, where a motor generator has been installed, reducing the pressure of the transmission line to one of 280 volts for distribution purposes.

W. H. S.

204. *Birkdale Electricity Works.* (Tram. Rly. World, 12. pp. 404–407, Sept. 11, 1902.)—This station has been provided for the supply of electricity for lighting and traction, there being 2 to 3 miles of single track within the area supplied. The station is situated on wet and sandy ground, necessitating foundations of armoured concrete. The generating plant consists of three Bruce-Peebles dynamos of 110 kw. each, at 440–500 volts, shunt-wound, driven by Browett-Lindley engines of the two-crank vertical compound type at 450 r.p.m.; for traction purposes the pressure is raised to 550 volts at full load with compound winding. Condensers of Messrs. W. H. Allen's surface type are installed, with Edwards pumps, and a Koppel cooling tower. There are three Babcock and Wilcox boilers, with Weir feed pumps, a Rankine feed-water filter, and a Berryman water heater. The boilers are fitted with induced draught apparatus. A battery of 270 cells, supplied by the Accumulatoren fabrik, of Berlin, has been provided, capable of giving 160 amperes for three hours: this is used for lighting only. A Bruce-Peebles booster-balancer has also been fixed in the engine-room. The switchboard was made by the Konstructionswerke Elektrischer Apparate, and is equipped for controlling the generators and battery, three lighting feeders, and one traction feeder. The cables were made and laid by Callender's Cable and Construction Company, Limited. The charge for energy for lighting is 7d. and 2d., on the maximum demand system. The tramway is laid with rails weighing 90 lbs. per yard. on a 6-in. concrete bed. The trolley system is used, with side poles and brackets. A. H. A.

205. *Kalgoorlie Electric Power Scheme.* (Elect. Rev. 51. pp. 447–450, Sept. 12, 1902.)—The station at Kalgoorlie was constructed to meet several local peculiarities. In the first place, the only available fuel is wood; and in the second place there is great scarcity of water. The rainfall is only half an

Digitized by Google

inch in the year; and the only other supply is obtained from the water pumped from the mines, which, when analysed, was found to contain 21 per cent. of sodium chloride together with many other impurities. This water is therefore treated by evaporation in shell boilers, which are worked in relays, a thickness of scale amounting to several inches being removed every day. The evaporating plant consists of 10 shell boilers, 20 ft. by 5 ft., the steam being thence conveyed to cooling drums, consisting of 40 corrugated iron drums, 24 ft. by 6 ft. 8 in., with flues 3 ft. 3 in. in diameter up the centre of each. There are four salt-water tanks, 40 ft. in diameter and 14 ft. deep, and six fresh-water tanks, 16 ft. in diameter and 8 ft. deep. The boiler-house contains eight Babcock boilers, each having 2,823 sq. ft. of heating surface, arranged for burning wood. The engine-room contains three 3-phase 40-cycle 500 kw. alternators, running at 100 r.p.m. In view of the amount of solid matter contained in the water, it was decided to be impossible to use the condensers of the ordinary kind. A form of air condenser was therefore adopted, built by Fouché, of Paris. There are three of these condensers, each condensing 16,000 lbs. of steam per hour, with the temperature of the incoming air at 85° F., and giving a vacuum of 14 in. With the variation of 4° in the temperature of the incoming air, the vacuum alters by 1 in. between the temperature limits of 70° and 95° F. The air supply is furnished by 27 fans, each 7 ft. in diameter, and capable of delivering in all 2,250,000 cub. ft. of air per hour. Drawings are given showing the arrangement of the condensing plant, which occupies nearly as much space as the boiler- and engine-house together. W. H. S.

206. *Great Northern and City Railway.* (Tram. Rly. World, 12. pp. 145–157, July, 1902.)—The paper gives a detailed description of the construction of the tunnels. The first 4,000 ft. of each tunnel were constructed in the usual way, after which it was decided to line only the top half of the tunnel with cast-iron, the lower half being brick-lined. A cast-iron bearer plate is interposed between the iron lining and the brickwork. The Greathead shields employed in driving the tunnels were more powerful than those hitherto employed in such work, necessitating some modifications in construction which are fully described in the paper. Sixteen hydraulic jacks, each 7 in. in diameter, were employed, with a pressure of 2 tons per sq. in. Photographic views and detailed drawings are given of the hydraulic crane or erector used for placing the cast-iron segments of the tunnel-lining in position. The permanent way in the tunnels consists of 85-lb. flanged rails laid on longitudinal wooden sleepers with transoms. The conductor rails, one on each side of the track, weigh 80 lbs. per yard, and "Crown" rail bonds are used. Steam is supplied by ten Davey-Paxman "Economic" boilers, each having a heating surface of 1,890 sq. ft., and a grate area of 41 sq. ft., working at a pressure of 160 lbs. per sq. in. Each boiler can evaporate 11,200 lbs. of water per hour. A Pearns feed pump is employed. There is a Hunt coal-conveyor with a capacity of 80 tons per hour, and Vicars' automatic stokers, driven by two motors, are used. There are four Wheeler surface condensers, each having a cooling surface of 2,400 sq. ft., and supplied with steam-driven combined air and circulating pumps. Two sets of Green's economisers and Desrumeaux water softeners are in use. Four generating units are installed, with space for a fifth when required. The engine in each unit is of the vertical marine cross-compound type, running at 100 r.p.m., and giving normally 1,250 i.h.p., with a considerable overload capacity. The stroke is 42 in., and the diameters of the cylinders are 27 in. and 52 in.

Digitized by Google

respectively. Corliss valves are used, and the main governor is coupled direct to the high-pressure cylinder valve gear. The speed regulation provides for a variation of not more than 8 per cent., even if the full load be suddenly thrown off; in case of accident to the main governor, a 5 per cent. increase in speed would bring an emergency governor into action and shut off the steam. Each engine can be worked, if desired, by the high-pressure cylinder only, or by the low-pressure cylinder only, condensing or non-condensing or compound condensing, or compound non-condensing. The flywheel is 19 ft. in diameter and weighs 40 tons. The dynamos are of the standard Thomson-Houston direct-driven railway type, rated at 800 kw. each, but capable of taking a 50 per cent. overload for two hours or a 100 per cent. momentary overload. They are compound wound to give 525 volts at no load, and 575 volts at full load. To supply power for lighting and auxiliary plant, when inconvenient to take it from the main generators, 220 kw. dynamos are supplied, compound wound for the same voltages as the main generators. These are driven by two Peache three-crank, high-speed vertical compound engines running at 375 r.p.m., and developing normally 170 b.h.p., with a momentary capacity of 260 b.h.p.

There is to be a three-minute service of trains of seven cars each worked on the multiple-unit system. The single journey of $8\frac{1}{2}$ miles will be completed in about $13\frac{1}{2}$ minutes, including three stops of 20 seconds each. The acceleration is to be as high as 2 ft. per sec. per sec. The maximum speed will be about 33 miles an hour, and the schedule speed 16 miles an hour. The normal arrangement of trains will consist of a motor car at each end of the train and one in the centre, with four trailers. G. W. DE T.

207. *London County Council's Conduit Tramways.* (Tram. Rly. World, 12. pp. 385–395, Sept., 1902.)—This work has been carried out by J. G. White & Co. to the designs of A. B. W. Kennedy. Several drawings are given in the present article. These include sections and plans of the tracks; elevation, sections, and plan of yoke: sections of slot-rail and conductor-rail; section of insulator mounted in position; section and plan of drainage and cleaning pit; section insulator and feeding cable arrangements. The yokes are 8 ft. 9 in. apart. The wheel rails are 7 in. high, and 7 in. across the base, with a groove of $1\frac{1}{16}$ in. wide on the straight track, and $1\frac{3}{16}$ in. on curves. Insulators are placed on every fourth yoke, *i.e.*, 15 ft. apart, each insulator being beneath a manhole frame and cover. The concrete tube is 6 in. thick. The slot is $\frac{3}{4}$ in. broad. The depth from the top of the slot-rail to the centre of the conductor-rail is 14 in., and there is a further depth of about 8 in. below to the bottom of the tube. The conductor-rails weigh about 21 lbs. per yard. Section insulators are placed at intervals of half a mile; at these points the conductor-rails are cut for a length of 2 ft. W. H. S.

208. *Goldstream-Victoria Transmission Plant, Canada.* (Canad. Elect. News, 12. pp. 155–156, Sept., 1902.)—Power is derived from a waterfall 700 ft. high. Three-phase current is generated at 700 volts, which is transformed to 17,000 volts for transmission to Victoria. W. H. S.

209. *Detroit Rapid Railway System.* **F. W. Brooks,** with **W. O. Wood** and **A. C. Marshall.** (Street Rly. Rev. 12. pp. 526–538, Sept., 1902.)—This is an interurban railway system, serving the districts north of Detroit, and comprises 118 miles of line working and 10 miles under construction. The rails outside the cities are standard railway rails weighing 60 or 70 lbs. to the yard. Inside the cities 7-in. T-rails of the

Digitized by Google

Lorain Steel Co. are used. The whole system is worked from one power-house by three-phase transmission. The power-house is situated at New Baltimore on Lake St. Clair. It is equipped with four Babcock and Wilcox 350-h.p. boilers with Roney mechanical stokers, Worthington feed pumps, and Green economiser. Ohio and West Virginia slack coal is used, the consumption being 5·75 to 6 lbs. per kw.-hour. There are three Westinghouse tandem compound engines 21¼ in. and 37 in. × 22 in. connected to three-phase generators of 500 kw. rated capacity each. There are two 40-kw. exciter sets. The trolley lines near the power-house are fed by 200 kw. rotary converters taking three-phase current at 390 volts directly from the main bus-bars. Seven 400-kw. static transformers in the basement are used for transforming up to 16,000 volts for the long-distance lines. The lines are carried on 35-ft. poles 7 in. diameter at the top. There is a 7-ft. cross-arm for the high-tension wires and a 5-ft. cross-arm for the direct-current feeders placed 4 ft. below it. Porcelain insulators are used, the pins being of iron with a wooden thread and a porcelain sleeve. The high-tension line is diverted from the route at Mt. Clemens and Marine City being carried on an independent pole line round the outside of these cities. There are six sub-stations, including the substation machinery in the main power-house. They are in the passenger and goods stations and no special attendance is provided. There are 12 cars, 55 ft. over all, and 18 smaller cars, 46 ft. over all, for main-line service, and 32 single-truck cars in the various towns for local service. [See also Abstract No. 1196 (1900).] A. E. L.

210. *Detroit, Ypsilanti, Ann Arbor and Jackson Railway.* **F. E. Merrill.** (Street Rly. Rev. 12. pp. 537–542, Sept., 1902.)—The system has grown up since 1897 and now comprises 60 miles of line. The track is laid with 75-lb. rails on 8-ft. cedar sleepers laid 2 ft. centre to centre. The rolling stock consists of 33 standard closed cars and 4 open ones. A special roller-bearing trolley wheel is used and a travelling trolley base, running on angle irons the whole length of the car, so that it is always at the rear end whichever be the direction of motion. Spoked wheels, 36 in. diameter, weighing 575 lbs. each, are used on 5⅜ in. steel axles. The treads are 2¼ in. broad, with $\frac{11}{16}$ in. flanges. The older parts of the line are supplied with power by a continuous-current station at Dearborn, while at Ypsilanti is an alternating-current station feeding six substations. There are eight 225-h.p. Babcock and Wilcox boilers with Roney mechanical stokers. Five 250-kw. three-phase generators and three 250-kw. double-current generators, all of Westinghouse make, are coupled to Westinghouse engines, 18 in. and 30 in. by 16 in., running at 250 r.p.m. Three 500-kw. self-cooling, oil-insulated transformers are used to step up the voltage from 390 to 22,000. There are three circuits, one east to Wayne and Dearborn substations, 20 miles, one west to Ann Arbor, Lima Center and Francisco, 30 miles, and one to Michigan, 41 miles. [See also Abstract No. 1194 (1900).] A. E. L.

211. *Detroit United Railway Power Stations.* **T. Farmer.** (Street Rly. Rev. 12. pp. 518–525, Sept., 1902.)—The author describes the six power stations and three accumulator stations of the system, which are as follows:—*Station A.*—Near the business centre of the city. It contains twelve Babcock and Wilcox boilers 250 h.p. each, with Murphy stokers and Hoppes' live steam purifiers. There is a Hunt conveyor for coal and ashes, and a steel smoke-stack 180 ft. high and 11 ft. 6 in. inside diameter. Four Reynolds-Corliss compound condensing tandem engines, 28 and 52 by 48 in. are direct-connected to 1,000-kw. Siemens and Halske outside armature generators. *Station B.*—This

Digitized by Google

is close to Station A, and is controlled by the switchboard in the latter. It contains eight Stirling boilers of 300 h.p. each and eight of 250 h.p. each, with Murphy stokers, Green economisers, and a brick stack 185 ft. high with 10 ft. flue. There are two Reynolds-Corliss cross-compound condensing engines, 20 and 40 by 48 in. direct connected to 400-kw. Walker generators, two similar engines but 24 and 48 by 48 in. connected to 800-kw. Walker generators, and one Filer and Stowell cross-compound condensing engine, 32 and 64 by 60 in. connected to 1,500-kw. Westinghouse generator. *Station C.*—A battery station situated opposite to Station A. This contains a battery of 276 chloride cells having each 67 plates $15\frac{5}{16}$ in. square. The discharge capacity is 2,500 amperes at 575 volts for 1 hour, 1,250 amperes for 3 hours, or 625 amperes for 8 hours. A 250-kw. booster is used for charge and discharge. *Station D.*—This is at Farmington Junction, 19 miles from the City Hall. It contains eight Aultman and Taylor boilers of 250 h.p. each with Murphy stokers, and three Reynolds-Corliss engines 26 by 48 in. direct coupled to 400-kw. Siemens and Halske outside field generators. *Station E.*—This is at Birmingham, 18 miles from the City Hall, and contains one Babcock and Wilcox 250-h.p. boiler with Roney stoker, and three fire-tube boilers of 125 h.p., each hand fired. There are two Westinghouse compound condensing engines 16 and 30 by 18 in., belted to 250-kw. Westinghouse generators. *Station F.*—This is at Pontiac, 26 miles from the City Hall, and is only used in case of emergency. It contains two Phœnix Iron Works 100-h.p. boilers, one 16 by 15 in. Dick and Church engine, and one 15 by 16 in. Ball engine, each belted to 100-kw. Westinghouse generators. *Station G.*—This is at Rochester, 28 miles from the City Hall. It contains four 250-h.p. Aultman and Taylor boilers. There are two 325-h.p. Ball and Wood horizontal tandem compound condensing engines, 15 and 30 by 16 in. direct, connected to Crocker-Wheeler 200-kw. generators, and a $21\frac{1}{2}$ and 45 by 20 in. Ball and Wood vertical cross-compound condensing engine, direct connected to a Crocker-Wheeler 400-kw. generator. There is a motor-generator set for local lighting, a booster for the distant part of the line, and a 250-kw. rotary convertor with step-up transformers, feeding at 15,000 volts through lines 13 miles and 30 miles long to the Oxford and Atlas substations, where are step-down transformers and rotary converters. *Station H.*—This is a battery station, situated on an equaliser connected to the various feeders, about $3\frac{1}{2}$ miles from Stations H and B. It contains a battery of 250 chloride cells, having each 52 plates with a discharge capacity of 2,000 amperes at 500 volts for 1 hour, 1,000 amperes for 3 hours, or 500 amperes for 8 hours. *Station I.*—This is a battery station at Ecorse, about $10\frac{1}{2}$ miles from the power-house. It contains 276 chloride cells, type F-15. It has a discharge capacity of 280 amperes for 1 hour. [See also Abstract No. 1591 (1900).] A. E. L.

212. *Track Department of Detroit United Railway.* (Street Rly. Rev. 12. pp. 542–546, Sept., 1902.)—The company works about 390 miles of track, and has introduced novelties in construction. Concrete underbeds were early used, but the earlier ones were of insufficient depth and quality. Experiments are being made with cross-sleepers of concrete. Various safety devices for switches are described and illustrated. Other special appliances designed by the department are a portable emery wheel, portable pile-driver, yard derrick for handling rails, derrick car, and travelling rail spiking machine.

A. E. L.

213. *Hamburg-Blankenese Electric Tramway.* (Tram. Rly. World, 12. pp. 410–411, Sept., 1902.)—This tramway is 19·4 km. in length, with the

Digitized by Google

power-house near the middle. The latter contains three Lancashire boilers, fed with two Worthington pumps, and two compound engines of 200–250 h.p. each, fitted with Rider expansion gear on the high pressure cylinder, and Corliss gear on the low. The cylinders are 400 and 630 mm. in diameter, with a stroke of 400 mm., and run at 180 r.p.m. The exhaust steam is condensed for feed water, and there is a cooling tower, over which the condensing water is pumped. The engines are coupled to shunt-wound dynamos with 18-pole fields, generating each 280–350 amperes at 500–550 volts; the pressure can be raised to 750 volts to charge the storage battery, which consists of 250 cells with a capacity of 264 ampere-hours. The current is conveyed to the cars by two trolley wires, the return being by the rails. In the town the latter are laid on longitudinal concrete sleepers 150 mm. × 300 mm., and weigh 42 kg. per metre; outside the town the concrete is replaced by gravel. The cars accommodate each 30 passengers seated, and nine standing; there are 16 motor cars, each fitted with two Helios 20-h.p. motors, with electrical disc brake, and weighing 11·65 tons each when empty.

A. H. A.

214. *Liverpool Overhead Railway.* (Tram. Rly. World, 12. pp. 401–404, Sept., 1902.)—For the description of this railway see Abstracts Nos. 1440 (1901), and 2351 (1902). With the original equipment the trains ran from end to end in 32 minutes, including sixteen stops, at an average speed of 12½ miles per hour. Experiments undertaken with a view to accelerating the service showed that the distance could be traversed in 20½ minutes, the acceleration during starting being 4·2 ft./sec.², and during stopping 4·75 ft./sec.² The consumption of energy was 137 watt-hours per ton-mile, and the schedule speed was 19½ miles per hour. Each train was equipped with four 100-h.p. motors, built by Messrs. Dick, Kerr & Co., who received the order for re-equipping the whole of the rolling stock. The efficiency of the motors was found to be 92 per cent. at full load, and their weight 43·8 lbs. per h.p.; they are similar in construction to tramway motors, but the top half is removable for inspection instead of the bottom half. The temperature rise of the motors above that of the air was 57° C. on the fields, and 39° C. on the armature. The motors are journalled on the driving axle at one end, and supported by springs on the bogie frame at the other. With the new equipment, twelve trains replace fourteen of the old type, accommodating the same number of passengers, and at the same time the headway is reduced from 5 to 3½ minutes. The plant at the power station has been increased by the addition of a boiler, superheater, and condensing plant, and a Browett-Lindley 1,500-h.p. engine driving a British Schuckert dynamo at 230 r.p.m. Illustrations of the motors and trains, and characteristic curves, are given. A. H. A.

215. *Electrical Equipment of the Consolidated California and Virginia Mining Co., Nevada.* **L. M. Hall.** (Elect. Rev. N.Y. 41. pp. 298–302, Sept. 6, 1902.)—This paper describes a very large and important plant for transmitting and utilising power in mining operations. The generating plant consists of two 1,400-h.p. turbines working with a head of 85 ft. These drive three-phase 60 ∿ revolving armature generators with 22-kw. exciters. The current is generated at 500 volts, transformed by oil-insulated transformers to 24,000 volts, and conveyed 33 miles by bare wires on 7½ in. Locke insulators supported on pine cross-arms on 30-ft. redwood poles. At Virginia City the pressure is lowered to 2,300 volts, and distributed to the mining companies. The charge is 7$ per h.p. per month gauged upon a two-minute maximum demand. A

Digitized by Google

large consumption of power takes place at the mine in question. The largest motors are a 200-h.p. variable speed induction motor working a hoist, a 100-h.p. similar motor driving an air compressor, and three of 225-h.p., working Riedler pumps underground, besides many smaller ones; the lighting plant is by the Westinghouse Co. The cost of power locally is 28$ per h.p. month, so that the electric power only costs one-fourth that of the power generated locally. LL. B. A.

216. *Power Equipment of the Westinghouse Works.* (Elect. Rev. 51. pp. 428–430, Sept. 12, 1902.)—The plant includes four boilers by Babcock and Wilcox, each of 500 h.p.; two steam alternators of 750 kw., and two others of 250 kw. The alternators give three-phase current at 440 volts, and 25 cycles. There is also a 400-kw. rotary converter, giving direct current at 500 volts, and worked up to speed by a small induction motor. The shops are driven by induction motors, which are started by current from small transformers, and, when started, are thrown on the 440-volt mains. W. H. S.

217. *Electric Driving at Howard's Works, Bedford.* (Elect. Rev. 51. pp. 444–445, Sept. 12, 1902.)—A description of the installation at these works. The plant at present includes two Lancashire boilers, 30 ft. by 7 ft. 6 in., and a dynamo giving 145 kw. at 230 volts. The motors in all amount to about 180 e.h.p. The plant is to be extended by the addition of a further generator of 165 kw., a saving of 400 tons of coal having been made during the year. W. H. S.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

218. *Electric Waggon Transporters.* **A. Taveau.** (Génie Civil, 41. pp. 261–264, Aug. 23, 1902.)—The paper contains an account of trials which have been made at Rheims by Druart and Le Roy, of electric transporters designed for the purpose of enabling broad-gauge waggons to be run on narrow-gauge railway and tramway lines. The transporters consist of low-built bogie trucks adapted to the narrow gauge, and each carrying a pair of rails on to which the waggon can be pushed by hand, the operation occupying about four minutes. Electric locomotives are employed for moving the trains of waggons carried on these transporters. G. W. DE T.

219. *Wear and Maintenance of Tramways.* **C. F. Wike.** (Tram. Rly. World, 12. p. 443, Sept., 1902. Abstract of paper read before the Association of Municipal and County Engineers at Bristol.)—The author, who is the city surveyor at Sheffield, states that the rails used there have not less than 0·35, and not more than 0·45 per cent. of carbon. In the discussion that took place on the paper, the opinion was expressed that this percentage of carbon produced too soft a rail, and it was stated that in Liverpool the average was about 0·45 per cent., and in some cases they had as much as 0·55. The author gives a table showing the amount of wear that has taken place on the Sheffield rails during thirty-four months, *i.e.*, the amount by which the depth of the groove has been reduced. Taking the first out of sixteen cases quoted, we find that on a gradient of 1 in 15 after 764,200 cars had passed, the depth

[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

Digitized by Google

of the groove had been reduced by 0·25 in. on the down track, and by 0·09 in. on the up track, amounting respectively to 54·1 and 15·1 per cent. of the total possible reduction of the sectional area of the tread of the rail. Figures are also given showing the cost of maintenance of the various kinds of pavement. Of these, granite paving costs about £19 per mile of single track per annum; granite-paved tracks with macadam sides, £47; gritstone, £49; wood paving, £54; and tar-macadam with a single row of sets adjoining each rail, £64.

W. H. S.

220. *Taeggi's Electric Post.* **W. P. Digby.** (Engineering, 74. p. 411, and pp. 419–420, Sept. 26, 1902.)—This is a system of telpherage in which the motor-vehicle runs on two pairs of insulated wires which are arranged on poles at two different levels, and also serve as conductors. The motor-vehicle consists of a motor having flanged driving wheels mounted at the ends of its spindle and insulated therefrom, these wheels running on the upper pair of wires; and a despatch-box, the upper end of which is secured to the motor, whilst the lower end of this box is provided with flanged trailing wheels running on the lower pair of conductors, which are arranged nearer together than the other two. The weight of the box and letters is to be 80 lbs. The poles carry three main feeders, supplying a 5,000-volt, three-phase current which is transformed down to 260 volts, the three low-tension mains being formed respectively by the two upper conductors and one of the lower ones. The transformers are to be arranged about 3 or 4 miles apart. In order to cut off all current from a block-section when there is a despatch-box in the section immediately preceding, the trailer of the despatch-box is arranged to short-circuit the two lower wires and thus complete the circuit of an automatic circuit-breaker which cuts off the current from the section behind. Stopping at a station is effected by cutting off the current in sections in advance of the station, and applying a brake to either side of the outer flange of the driving wheels by mechanism under the permanent way. The electric opening of switches for the points or turn-outs of the permanent way is effected by insulated contact strips, which are carried by means of an ebonite rod on two miniature trolley-poles, and make contact with an additional insulated wire supported on the poles in the middle above the upper pair of conductors.

C. K. F.

221. *Graphical Solution of Traction Problems.* **P. Pforr.** (Elektrotechn. Zeitschr. 23. pp. 650–652, July 24, 1902.)—The author extends the graphical method explained by him in a previous paper [see Abstracts Nos. 1844 and 2086 (1901)] to the problem presented by a long railway line supplied by a number of power stations arranged at given distances from the line. Two cases are considered by the author, the first being that of a simple line; the second, of a branched line.

A. H.

222. *Train Lighting.* **Strymeersch.** (Assoc. Ing. El. Liège, Bull. 2. pp. 132–160, Aug., 1902.)—The author traces the history of the lighting of railway carriages from 1825, the inaugural year of railways, when travellers desiring light were obliged to purchase a penny candle, through the colza oil, gas, and acetylene stages up to the present time. The various systems of electric lighting which have been tried are described, including the coupled engine and dynamo carried on the locomotive; the dynamo placed in the guard's van driven by belt from the axle, and supplemented by a battery of accumulators; the accumulator system in which each carriage carries its own

Digitized by Google

set, charged at a terminus; and the systems in which each carriage carries a dynamo and accumulator. In the last category the Stone system is included—a system now in use on the Belgian State Railways. In this system a dynamo is suspended beneath a railway carriage, and driven by belt from the axle. The mode of suspension is such that the belt is kept taut by the weight of the dynamo, and when the speed of the driving axle rises beyond a certain value the belt slips, and the speed of the dynamo remains constant, no matter what the speed of the train may be.

The dynamo is separately excited by a battery of accumulators. A centrifugal governor operates the main charging switch, causing the circuit to close when the e.m.f. of the dynamo is slightly above that of the battery. Automatic devices change over the battery connections on the reversal of the train's direction. The various details of the system are fully described and illustrated by diagrams. The essential differences between the Vicarino and the Stone systems are discussed. In the former the battery plays but a less important *rôle* than in the Stone system. In the latter, therefore, the weight of the battery is comparatively greater, and the cost of the system is somewhat more costly than the Vicarino system. Whilst actual comparative figures of cost cannot yet be given, the author says that the electric lighting of trains is not more expensive than gas lighting, and is more economical than colza oil lighting. Quoting from a paper by Banovits in the Bulletin de la Commission Internationale du Congrès des Chemins de Fer (October, 1901), the cost per candle-hour is given as 0·0028 francs for colza oil, and from 0·0001 to 0·0025 for gas. These figures only cover the cost of consumption, to which depreciation and repairs need to be added. Sartiaux estimates the cost of electric light by accumulators, charged at fixed points, at 0·029 francs per 10-c.p.-lamp per hour. The author calculates the cost of the Vicarino system as approximately 0·006 francs per lamp-hour, exclusive of depreciation and repairs. The Stone system would, under the same conditions, cost about the same. On the Jura-Simplon Railway the cost of the Stone system, according to Dr. Büttner, is 0·044 francs per candle-hour. This is about the same value as on the Belgian State Railways. F. B.

223. *Electric Brakes.* **G. H. Fawcus.** (Elect. Rev. 51. pp. 531–532, Sept. 26, 1902.)—The proposed brake is intended to prevent a car from running backwards down a hill. When brought to rest the motors should be left short-circuited on one another in such a way that the armature of the one is in series with the field of the other. If then the car tends to run away backwards, the armature of the one motor sends a current in the opposite direction through the field of the other. The second motor therefore generates current in the same direction as before, both its direction of rotation and its field being reversed, and as the result of this generator action the speed of the car cannot seriously increase. W. H. S.

224. *Automatic Signalling for the Block System, and Car-spacing Device.* (Street Rly. Rev. 12. p. 423, July, 1902.)—This system is somewhat similar to that described in Abstract No. 1980 (1902), but uses red, white, and green lamps, protected in the daytime from sunlight. Current is taken directly through trolley wheel, and drivers cannot interfere with signals. The circuits are independent of the trolley wire and connected from lamp to lamp. A white light permits a car to proceed on a single track with turnouts. As the car moves onward it automatically sets a green light on the near turnout and a red one on the turnout beyond. The car thus retains possession of a

Digitized by Google

certain section of line. Upon reaching the end of this section the green and red lights just passed are automatically switched to white or "clear line." A second car can follow the first, and any larger number, the green light being indicative of the fact that there is a car or cars in front and caution is to be exercised. In such cases the last car running in the same direction is caused to operate the clearing signals to accommodate those travelling contrariwise. For a double track the white, green, and red lights are so operated that the leading car is protected by the red, the green indicates caution, and the white admits of full speed to cars following. E. O. W.

ELECTRIC LAMPS AND LIGHTING.

225. *Arc Light Photometry.* **A. Blondel** and **J. Rey.** (Soc. Int. Élect., Bull. 2. pp. 593–614; Discussion, pp. 614–615, July, 1902.)—The authors examined continuous-current arcs of intensities from 25 to 300 amperes. Two methods were employed. In the first a beam of light from the arc is passed through an aperture in a diaphragm, and is then focussed by a lens on a screen. The photometer is then placed in the position of the screen, and the light emitted from the arc is calculated from the expression $EI^2/\lambda S$, where E is the reading obtained on the photometer, I is the distance of the image from the lens, S is the area of the aperture of the diaphragm, and λ is the coefficient of transmission of the lens. The authors found λ to be nearly equal to 0·9 in the lenses employed, and the apertures used varied from 2 to 5 mm. The second method is somewhat similar, but employs a white tile or a piece of drawing paper in place of the screen, the illuminated portion of the tile being limited by a circular opening of known diameter. This illumination is then measured by the photometer. The carbons used varied in size up to 49 mm. for the positive, and 35 mm. for the negative. Curves are given showing the results. It was found that the intrinsic illumination per sq. mm. of the surface of the crater, working in air, increased with the density of the current in the positive carbon. As the result of a theoretical examination, the authors assert that in carbons of different diameters, raised to the same temperature by the passage of current, the current density varies inversely as the square root of the diameter. With the same density of current in the positive carbons the intrinsic illumination increases with the diameter, but has a constant value in carbons which carry currents inversely proportional to the square roots of their diameters. The authors consider that the relation between intrinsic illumination and current density in the positive carbon can be approximately represented by a parabola, and this agrees fairly well with their experimental results. Various objections are urged against Violle's photographic methods, which are considered to lead to inexact conclusions. Finally, the authors give an empirical value for the area of the crater in sq. mm. as being $mi^{\frac{3}{4}}$, where m is about 0·2, and i is the current carried. W. H. S.

226. *The Nernst Lamp.* (Amer. Electn. 14. pp. 420–422, Sept., 1902. Discussion at the Cincinnati Electric Light Convention.)—A large number of users gave their experience of the lamp under working conditions. Practically all agreed in thinking that the lamp was a commercial success. One user recorded that his lamps had an average life of 1,800 hours on alternate-current circuits with a frequency of 125. The discussion was closed by **A. J. Wurts.** He pointed out that a short life is sometimes caused by

Digitized by Google

mechanical strain. A glower expands and contracts when lighted or switched off. It should have an end play of about $\frac{1}{16}$ of an inch; its life should then be about 800 hours on 60 cycles, or 400 hours on 25 cycles. On 133 cycles the life appears to be about 1,200 hours. Apparently no direct-current lamps have yet been sold in America, but they will be started shortly, and will be similar in all respects to the existing lamps, except in so far as the filament is concerned. Lamps must be placed in a downward vertical position, as the cut-out works by gravity, and a spring cut-out is not reliable. The light of a Nernst lamp increases about 12 per cent. for a 5 per cent. increase in voltage; if run for some hours at this increased voltage, the life of the filament is not seriously decreased, but if so run continuously, the life is somewhat diminished. If run continuously on a voltage increased by 10 per cent., the tube containing the series resistance is somewhat blackened; 15 per cent. increase will make the tube very black, and a 20 per cent. rise will heat the tube sufficiently to soften the glass. Thus by inspection of this tube, it is possible to form some idea of the treatment to which the lamp has been subjected. If a filament gives out in less than 200 hours, it is almost certainly due to mechanical strains. On account of the corrective power of the series resistance, it should be impossible to burn out a filament in less than 200 hours, even with an increased voltage of 10 or 15 per cent. above the normal. The series resistance in that case generally goes first, but not unless the voltage is continuously raised by 15 per cent. **E. F. Phillips** said that in Detroit the lamps had worked well, and competed better with the Welsbach light than either the incandescent lamp or the arc had been able to do. He thought there was a tendency on the part of the filament to warp, and thus to bring them so far from the heater that the lamp became very slow in starting up. This warping has been corrected in some cases by turning the lamps partly over, and in others by bending the terminals so as to bring the glowers closer to the heater. W. H. S.

227. *Electric Railway Lighting Regulation.* **H. Schuh.** (Elektrotechn. Zeitschr. 23. pp. 292–298, April 3, 1902.)—The author describes in detail a device for keeping the voltage on the lighting circuit of electric railways constant, although the pressure may vary considerably on the line. No accumulators are used in this device, but the regulation is made through a series of resistances which are automatically switched into series with the lamps, or taken off as the pressure increases or decreases on the line. The device is simple in construction and has been used at the le Fayet-St. Gervais-Chamonix Railway by the Elektrizitäts Gesellschaft Alioth of Basle. The author gives a diagram showing the action of the Relays, and the switching arrangements. L. G.

REFERENCES.

228. *Advantages of Electric Transmission.* **F. J. A. Matthews.** (Mech. Eng. 10. pp. 81–83, July 19, and pp. 161–164, Aug. 2, 1902.)—This paper deals mainly with the results already published by Miller, Benjamin, and others. W. H. S.

229. *Cost of Power.* **M. J. Eichhorn.** (West. Electn. 31. pp. 69–70, Aug. 2, and pp. 88–89, Aug. 9, 1902.)—In central electric supply stations the author considers the effect of load factor on cost, and to what extent it is worth while spending capital in order to increase the load factor. G. H. B.

Digitized by Google

230. *High-Tension Work in the Far West.* **G. H. Lukes.** (Elect. Rev. N.Y. 41. p. 371, Sept. 20, and p. 411, Sept. 27, 1902. Abstract of paper read before the Association of Edison Illuminating Companies, Sept. 9, 1902.)

231. *Pressure Rises in High-Tension Transmission.* **W. B. Woodhouse.** (Electrician, 49. pp. 785–786, Sept. 5, 1902.)—An article in which the author considers the conditions under which abnormal rises of pressure are liable to take place, and the methods of protection. A. H.

232. *Speed Power and Efficiency Curves.* **E. J. Burdick.** (Street Rly. Rev. 12. pp. 534–536, Sept., 1902.)—An example is given of the curves plotted from tests of a car on the line furnishing a check on the condition of the latter as well as on the motors. A. E. L.

233. *Collectors for Heavy Traction.* **G. T. Hanchett.** (Street Rly. Journ. 20. pp. 13–16, July, 1902.)—The author gives detailed descriptions and drawings of the contact shoes employed on the Boston Elevated Electric Railway and on the Berlin Elevated and Underground Electric Railway. He also discusses the general question of third-rail practice, with regard both to current collection and the support and insulation of the third rail. G. W. DE T.

234. *Dolter Surface Contact System.* (Elect. Rev. 51. pp. 487–490, Sept. 19, 1902.) —This system, which is in operation in Paris, is briefly described and discussed. [See also Abstract No. 299 (1901).]

235. *Overhead Construction of Detroit United Railway.* (Street Rly. Rev. 12. pp. 546–549, Sept., 1902.)—The paper contains a description of the overhead construction used for the high- and low-tension circuits with the instructions issued to linesmen for use on repair work. A. E. L.

236. *Electric Locomotive for Rack Railway.* (Feilden, 7. pp. 69–72, July, 1902.) —This is a description of an electric locomotive, intended to haul a load of 28 tons on an incline of 19 per cent. at the rate of 5½ miles an hour, working on the steep gradient of the Ouest-Lyonnais tramway between Lyons and the Saint-Just Plateau. W. H. S.

237. *Westinghouse Electric Vehicle Equipment.* (Horseless Age, 9. pp. 762–764, June 25, 1902.)—Particulars with illustrations and diagrams of the motors, controllers, and minor fittings. E. J. W.

238. *Notes on the Resistivity of Track and Collector Rails, as affected by the Chemical Composition.* **S. Woodfield.** (Elect. Rev. 50. pp. 1047–1049, June 27, 1902.)—The paper gives a number of analyses of different kinds of steels employed for electrical rails, comparing them with their respective conductivities.

239. *The Schuckert Projector.* **A. Bainville.** (Électricien, 23. pp. 17–21, July 12, 1902.)—This is a description with drawings of a projector which was shown at the Paris Exhibition. W. H. S.

240. *Edison's Tungstate of Calcium Lamp.* **W. J. Hammer.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 473–480, June, 1902.)

Digitized by Google

TELEGRAPHY AND TELEPHONY.

241. *Proposed Non-Inductive Cable.* **C. E. Fritts.** (Elect. World and Engineer, 40. pp. 169–171, Aug. 2, 1902.)—The writer states that he has been granted letters patent for a method of suppressing inductive resistance from telegraph lines, and explains his method as follows: The continuity of the line is broken up into disconnected sections. The sections are then connected in series through condensers or inductance coils, the electrical impulses being transmitted over these junctions by induction, and over the separate sections by conduction. [The method appears to resemble that suggested some years ago by S. P. Thompson. A similar case was treated mathematically by W. A. Price (see Proc. Physical Soc., vol. 15, pp. 100–115, April, 1897).] R. A.

242. *Braun Wireless Telegraph System.* **A. F. Collins.** (Elect. World and Engineer, 89. pp. 1041–1048, June 14, 1902.)—After describing Braun's inductive receiver and transmitter [see Abstracts Nos. 1464 and 2068 (1901)], the author gives a brief account of the theory of the apparatus. The circuit-breaker employed is Simon's form of Wehnelt's interrupter, improved and simplified by Siemens and Halske. The closed oscillating system consists of a series of Leyden jars and a transformer, the former being constructed of glass tubes 25 mm. in diameter. An unexhausted coherer is employed, with steel conductor plugs separated by hardened sifted steel powder. The sensitiveness is stated to be equal to that of the best vacuum silver-nickel coherer, while it is less susceptible. Braun has found that this coherer responds more slowly and is less reliable when the conductor plugs are magnetic; but that a certain critical magnetisation increases the sensibility without sensibly affecting the reliability. A magnetic regulator is therefore employed, consisting of a permanent ring magnet having the conductor terminals of the coherer between its poles. Regulation is effected by rotating the magnet, and thereby altering the distance between its poles and the ends of the plugs. G. W. DE T.

243. *Detection and Determination of Direction of Wireless Telegraph Signals.* (Elektrotekn. Tidsskr., Christiana, 15. pp. 175–176, Oct. 6, 1902.)—G. F. R. Blochmann has devised and patented an apparatus in which dielectric lenses, placed at the transmitting station, concentrate the rays in any required direction. The receiving apparatus either rotates about its axis at a convenient speed, so as to ascertain the direction of the rays received, if this is unknown, or, if known, is turned in the required direction. It contains a similar lens or system of lenses to those at the transmitting station. The whole arrangement is analogous to an ordinary projecting apparatus. A. G.

244. *Telephony over Telegraph Lines.* **F. Nissl.** (Zeitschr. Elektrotechn., Wien, 20. pp. 870–872, July 27, 1902.)—Diagrams are given showing how to arrange a telephone system to work over telegraph lines, or over the wires of railway signalling system. The arrangement is said to be good enough for service messages; it is not intended for public usage. There appears to be no serious mutual interruption between the two systems, but some amount of

Digitized by Google

interference is inherent. The telephone circuit at each station is a shunt to earth through a condenser and induction coil. The telephone call is a separate microphone, consisting of a thin carbon diaphragm, provided with a middle carbon contact-piece held by an adjusting spring. R. A.

245. *Telephony in Berlin.* **Dankwardt.** (Archiv Post Tele. 14. pp. 431–448, July, 1902.)—The Telephone Exchange in Berlin has been provided with a good deal of new apparatus, somewhat on the principles adopted by the British postal telephone service. Early in 1902 the switch-boards were rearranged, increasing the number of jacks for subscribers and junction lines. The system was further modernised by replacing the old indicators by visual signals, and by arranging for a better distribution of the subscribers' jacks to equalise the work among the operators at the exchange. Diagrams are given showing the connections for the multiple-jack system, together with particulars of the Exchange apparatus, including polarisation cells, control clocks, jacks, relays, batteries and junction wires. [See also Abstract No. 424 (1902).] R. A.

REFERENCES.

246. *The Coherer for Submarine Cable Work.* **E. Guarini.** (Elect. Rev. 50. pp. 492–493, March 21; 567–568, April 4; 1049–1051, June 27; and 51. pp. 3–4, July 4, 1902.)—The author discusses a suggestion of M. O'Gorman's that *coherers* might be of value in submarine telegraphy, and proposes various arrangements both for single and duplex working. G. W. DE T.

247. *Needed Improvements in Independent Telephony.* **L. W. Stanton.** (Elect. Rev. N.Y. 41. pp. 56–58, July 12, 1902. Paper read before the Independent Telephone Association of the United States at Philadelphia, June 25.)—Advocates the extended use of party lines. E. O. W.

248. *The Economic Design and Management of Telephone Exchanges.* **A. V. Abbott.** (Elect. World and Engineer, 38. pp. 929–930, Dec. 7; 982–983, Dec. 14; 1020–1021, Dec. 21; 1063–1064, Dec. 28, 1901; and 39. pp. 20–21, Jan. 4; 157–158, Jan. 25; 266–267, Feb. 8; 390–392, March 1; 511–514, March 22; 681–686, April 19; 815–817, May 10; 1086–1088, June 21; and 40. pp. 212–214, Aug. 9, 1902.)

249. *The Future of the Telephone in the United Kingdom.* **J. E. Kingsbury.** (Electrician, 49. pp. 907–910, Sept. 26, 1902. Paper read before Section G of the British Association, at Belfast, Sept., 1902.)

Digitized by Google

SCIENCE ABSTRACTS.

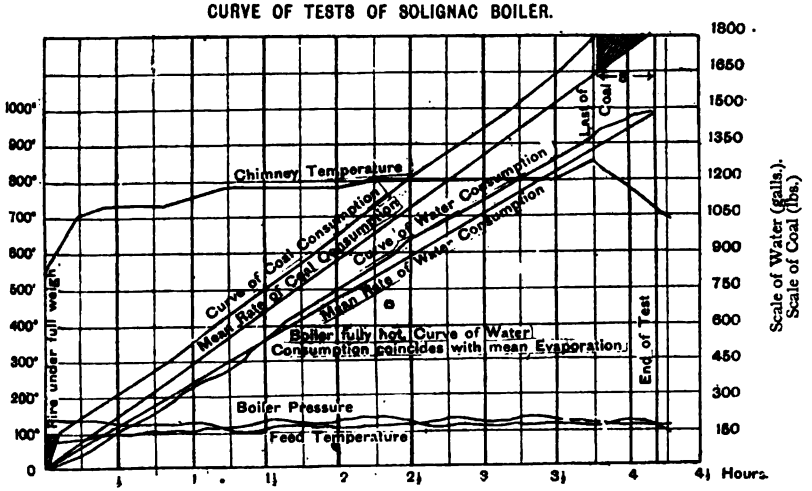
Section B.—ENGINEERING.

MARCH 1903.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

250. *The Solignac Boiler.* **W. H. Booth.** (Electrician, 49. pp. 998–1000, Oct. 10, 1902. Paper read before Section G of the British Association at Belfast.)—The example tested by the author consisted of a small steam drum maintained about half full of water, two flat headers, one of which extended downwards from the bottom of the drum and formed the downcast passage


CURVE OF TESTS OF SOLIGNAC BOILER.
Chimney Temperature
Curve of Coal Consumption
Mean Rate of Coal Consumption
Curve of Water Consumption
Mean Rate of Water Consumption
Boiler fully hot. Curve of Water Consumption coincides with mean Evaporation.
Boiler Pressure
Feed Temperature
Fire under full weight.
Last of Coal fired
End of Test
Scale of Water (galls.). Scale of Coal (lbs.)
Hours.

for the water to the tubes, and 118 small horizontally placed tubes of about 1 in. internal diameter and about 4 ft. long. These tubes were bent back upon themselves in ⊐-form, the upper end being connected to the second header communicating with the top half of the drum, and therefore forming the upcast passage for steam. The lower ends of the tubes were fitted with brass nozzles, each having an opening of $\frac{7}{32}$ in. diameter, and the openings

Digitized by Google

from the steam drum to the three divisions of the lower header were of small area. The principle aimed at in this boiler is to secure a supply of water not seriously greater than the tube will evaporate, so that very little water is discharged with the steam. Each tube dealt with about half a gallon of water per minute, measuring about 140 cub. in., the rate of flow being about 2½ cub. in. per second, so that the velocity was 5 ft. per second through the nozzles. The circulation of water was steady and uniform, and no evidence of overheating appeared. The mean velocity of flow of steam in the tubes was fully 46 ft. per second. With hot feed the boiler with 10 sq. ft. of grate surface—ratio of heating to grate surface 37 to 1—can deal with at least 4,000 lbs. per hour of water, producing that quantity of dry steam. The floor space occupied was 27 sq. ft., so that the boiler can supply steam for about 10 i.h.p. for each cubic foot of volume contained within the casing. The output makes the boiler suitable for small vessels of the torpedo-boat class, and its rapidity of steam-raising renders it a useful adjunct to electric light stations, for dealing with sudden accessions of load, or the peak of the ordinary night load, without much waste of heat.

A tabular statement of the results of eight tests accompanies the paper—the first five having been made with French, and the rest with English grate bars. One of the tests was made by the Vulcan Insurance Company. The best Welsh coal, having a calorific value of 15,000 B.Th.U., was used in all the tests, and the evaporation per sq. ft. of heating surface per hour, from and at 212° F., ranged from 5·38 to 11·92 lbs., the coal consumption being from 19·69 to 42·5 lbs. per sq. ft. of grate area, with draught of ¼, ½, and 1 in. water gauge. During the tests both coal and water were supplied in small weighed quantities, so that the curves of consumption might be drawn with fair accuracy. The accompanying diagram shows the regularity of the boiler performance.

F. J. R.

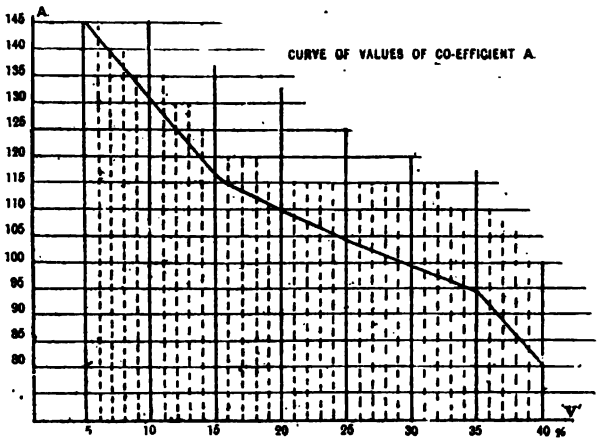
251. *Water-Tube Boilers.* (Scientific American, 87. p. 148, Sept. 6, 1902.)—Tests made on tubes 3 in. in diameter showed that when the tube was simply expanded into the tube-plate it required a force of 6,300 lbs. to withdraw it, while if the tube was expanded and then flared a pull of 19,700 lbs. was required. From this it is calculated that with 4 in. tubes and a boiler pressure of 200 lbs. per sq. in. the factor of safety of the attachment of the tubes to the plate is only about 2½ when the tubes are simply expanded, and is 7·8 when the tubes are properly flared. H. R. C.

252. *Calorific Power of Coal.* **Goutal.** (Comptes Rendus, 185. pp. 477–479, Sept. 22, 1902.)—The use of the Mahler bomb calorimeter has frequently revealed discrepancies between actual calorific powers and those calculated by means of the formulas hitherto proposed. The author has abandoned the use of the formulas of Dulong, Scheurer-Kestner, Cornut, Ser, and Gmelin as being incorrect or founded upon delicate or complicated determinations. Nevertheless, as a simple calculation for finding calorific power, which possesses considerable interest from an industrial point of view, he has sought to establish a relation between calorific power as calculated and the results furnished by trials of fuels. The study of over six hundred samples of coal from different sources has convinced him that the results of trials are closely expressed by the formula $P = 82\,C + aV$, where P = the calorific power sought; C = the percentage of fixed carbon; V = the percentage of volatile matter; and a = a variable coefficient which is a function of the

Digitized by Google

amount of volatile matter V′ in pure combustible (*i.e.*, without ash or water), so that $\left(V' = \frac{V}{100C + V}\right)$.

The following curve has been traced from the results of numerous trials, in order to fix experimentally the value of a for different fuels; the abscissæ showing percentages of volatile matter V′, and the ordinates the corresponding values of a drawn from calorimetric combustions. For the following amounts of volatile matter, viz., 5, 10, 15, 20, 25, 30, 35, 38, and 40 per cent., the coefficient a has successively the values in calories, 145, 130, 117, 109, 103,



98, 94, 85, and 80. In the case of anthracite a is represented by a constant equal to 100 calories, and the formula becomes $P = 82\,C + 100V$. The error from the use of this formula rarely exceeds 1 per cent. of the actual value in the case of ordinary coal, and is seldom above 2 per cent. in the case of some anthracites and lignites which can be studied only by means of a calorimeter. The curve is applicable in the case of distillation of coal, and to all the varieties of coal from anthracite to lignite. The author gives the calorific power of pure anthracite at 8,250 calories; that of anthracitic coal, with V′ = 5 to 10 per cent., at about 8,550; and a maximum of 8,700 calories for the coals of which V′ = from 10 to 30 per cent. F. J. R.

253. *Machine for Testing Lubricating Oils.* **G. Dettmar.** (Elektrotechn. Zeitschr. 23. pp. 741–745; Discussion, pp. 759–760, Aug. 21, 1902. Report read before the 10 Jahresversammlung des Verbandes Deutscher Elektrotechniker at Düsseldorf.)—The apparatus described is intended to give a reliable test of an oil with a twenty minutes' trial, the conditions encountered in practice being reproduced as nearly as possible. The machine consists of a single test bearing and a journal fitted with flywheels on either side. The journal having been run up to any desired speed, the motive power is uncoupled and a time-velocity curve is taken as the combination comes to rest, which usually takes five to fifteen minutes. The oil film used is 0·05 to 0·1 mm., the bearing load 8 kg. per sq. cm., and the journal diameter 80 mm., giving, at 2,000 revolutions, a circumferential velocity w of 8·14 m. per sec., and a mean value while slowing down of about 1·5. The author refers to his former papers [see Abstract No. 1775 (1899)] for the theory on which many of his deductions depend. Calling μ the coefficient of friction at 1 kg. per

Digitized by Google

sq. cm., he finds that $\mu = r \cdot w^x$, x having the values 0·55 at 28° C., 0·485 at 40°, and 0·387 at 70°. The usual final bearing temperature being about 40°, μ'' may be taken as $= r\sqrt{w}$. Calling T_1 and T_2 the times taken with two different oils for the machine to come to rest from the same speed, the author gives the relation $T_1 r_1 = T_2 r_2 = \text{const.}$, from which it is seen that the friction constant r for any oil is inversely proportional to T, the lubricating value of the oil being therefore directly proportional to T. Values for r are given for six different oils, but the paper does not clearly describe how the values were worked out. The value of r is absolutely independent of the prices; indeed, the cheapest oil tested gave the best results. The following relations are given incidentally: (1) $\mu = \text{const.} \times \text{r.p.m./T}$. (2) $r = \text{const.} \times \sqrt{\text{r.p.m./T}}$. (3) The total friction is inversely proportional to the thickness of the oil film, and is independent of the load, with bearings forming a closed sleeve, because the oil film maintains a constant average thickness all round. (4) If the bearing is divided into halves, with a space between them, and the top one carries only its own weight, the friction increases somewhat with the load, because the oil film below becomes thinner, while that above remains constant. (5) The author confirms B. Tower's temperature experiments, and finds that μ is nearly proportional to the temperature Centigrade. (6) The critical velocity at which μ becomes a minimum varies from 0·1 to 0·2 met. per sec. (7) With good lubrication the metals used have no influence on the friction. Bearing metal should wear well, and be a good conductor of heat. To avoid waste of time, a hot-water coil is advantageously employed to heat the bearing up to about 40° C., the usual final running temperature. The importance of only testing with one bearing is emphasised. Before testing in the machine, oil should be tried—(1) for acidity, by seeing that it will not tarnish bright copper strip, (2) for liability to harden, by rubbing two oiled plates together, and observing that they do not tend to stick after some hours' exposure in the open. Numerous trials have demonstrated that all trace of oil can be removed from the bearing by washing out with benzine and then using an air blast.

TESTS OF SIX OILS.

No.	T. 1,400 revs. to 0. Secs.	r.	Temp. °C.	Pfennig per kg.	r × Price (Relative Economy).	T.r.	μ (approximate) at 1 kg. per sq. cm. and 9·0 m. per sec. (from curves).
1	560	0·05	38	32	1·6	2·80	0·072
2	385	0·068	40·8	63	4·28	2·62	0·116
3	339	0·081	40	65	5·26	2·82	0·141
4	294	0·088	39·2	42	3·70	2·70	0·144
5	289	0 091	45·5	32	2·91	2·63	0·15
6	274	0·095	42	48	4·45	2·60	0·151

[1] T.r should theoretically be constant. By adopting No. 1 as their works oil, the author's Company effect a saving of 25 per cent., or £100 a year.

Discussion.—**Arnold** did not think that, with all oils, μ would vary directly as the temperature. **May** pointed out that the oil which tested the best when new would not necessarily give the best average results over a long period of use. **Wilkens** considered that the correct method of investigating friction necessitated the division of the friction into (1) cohesion,

Digitized by Google

(2) internal friction; but **Haas** regarded the estimation of the total friction as being of the most practical value, and mentioned that his firm tested oils by measuring the final temperature which the oil gives in a standard bearing, this being the simplest method that can be devised. **Dettmar,** in reply, said that his results always confirmed the relation between μ and the temperature, whatever the oil used. Experiments on the durability of oils are already in progress. R. C. R.

254. *The "Ados" CO_2 Recorder.* (Elect. Rev. 51. pp. 601–602, Oct. 3, 1902.)—Interest in this apparatus centres in its automatic action, whereby the operations which are carried out by hand with an Orsat apparatus are here performed by the Recorder itself. The motor is a bell (or small gas-holder) the interior of which is put into communication alternately with the gases in the chimney or flue, and with the atmosphere, by means of a valve worked by a rocking lever, so that once the machine is started by hand it continues to rise and fall at intervals of about five minutes. By means of a cord and balance weight this rise and fall causes the rocking of a wheel, the raising and lowering of the gravity bottle containing glycerine, and the working of two small gas pumps which send the flue gases through the apparatus. 100 c.cm. of gas being imprisoned by means of the gravity bottle and forced into a solution of caustic potash, which is ultimately forced into another vessel by the unabsorbed gas, the percentage of CO_2 absorbed is indicated by the extent to which the air in the second vessel is displaced by the caustic solution so thrust forward. A pencil-carrying lever draws a straight vertical line, the top of which marks the percentage. The curve drawn to touch the tops of a series of these lines gives a record of the working of a furnace as regards the CO_2 in the escaping gases. [See also Abstracts Nos. 1989 (1901), and 152 (1902).] F. J. R.

255. *Refuse Destructors.* **W. F. Goodrich.** (Mech. Eng. 10. pp. 537–540, Oct. 18; and pp. 562–564, Oct. 25, 1902.)—In this paper the author gives information as to the extent to which the destructor system has been adopted in Britain, and also the numbers of towns of various sizes which are still without it and are adhering to the objectionable system of tipping their refuse. The possible influence of destructors on the rates is pointed out, and the importance of high-temperature working and of the adoption of twin-cell or multiple-grate arrangements, as against the single-cell system, is emphasised. Labour costs in various districts are quoted, and the author concludes that these will run to from 1s. to 1s. 8½d. per ton for any kind of destructor. The value of clinker is also shown to vary, but when well burned it can always command a market. A proposed method of refuse "conversion" is touched upon and condemned. [See also Abstracts Nos. 204 (1901), 949 (1902).] F. J. R.

REFERENCES.

256. *Acceleration of Piston.* **J. N. le Conte.** (Amer. Soc. Mech. Engin., Trans. 23. No. 947, pp. 676–680, 1902.)—The author describes a graphical method of finding the acceleration of the piston for any configuration of the mechanism by means of lines drawn from the instantaneous centre of the connecting rod and arcs from that centre. [The instantaneous centre is at an inconveniently long distance for a large range of crank positions, and in any case the lines drawn are long compared with the line giving the result. Klein's construction is in every way preferable.] H. R. C.

Digitized by Google

257. *Expansion Joint.* **R. E. Curtis.** (Amer. Soc. Mech. Engin., Trans. 23. No. 934. pp. 469–471; Discussion, pp. 471–472, 1902.)—The author gives a description and drawing of a swivelling expansion joint for a main steam pipe 16 in. diameter, designed for a working pressure of 225 lbs. per sq. in. H. R. C.

258. *Economy of Mechanical Stoking.* **W. W. Christie.** (Eng. Mag. 23. pp. 528–542, July, and pp. 717–733, Aug., 1902.)—This is an illustrated article describing various systems of mechanical stoking, and discussing their effect on boiler efficiency. A diagram is given showing the relative economy of mechanical and hand stoking based on some twenty tests by different engineers. No details of the tests are given. G. W. DE T.

259. *Design of Gas Engines.* **J. Dunlop.** (Mech. Eng. 10. pp. 446–447, Oct. 4; 482–484, Oct. 11; and pp. 549–551, Oct. 25, 1902.)—The author deals with the design of gas engines working on the ordinary 4-stroke de Rochas cycle. Various tables are given, and several types of governors and starting arrangements are described and illustrated. G. W. DE T.

260. *Commercial Development of the Gas Engine* (Mech. Eng. 10. pp. 499–503, Oct. 11; 535–536, Oct. 18; and pp. 569–570, Oct. 25, 1902.)—The paper, which is mainly historical, strongly advocates the more extensive utilisation of waste blast-furnace gases for driving gas engines on the Thwaite-Gardner system. G. W. DE T.

261. *Smokeless Combustion of Bituminous Fuels.* **W. H. Booth.** (Electrician, 49. pp. 996–998, Oct. 10, 1902. Paper read before Section G of the British Association at Belfast.)—The paper deals principally with combustion in steam-boiler furnaces, showing the conditions which produce smoke. [See also Abstracts Nos. 2449 and 2450 (1901).] F. J. R.

262. *Feed Waters and their Action on Boilers.* **C. A. Bowen.** (Elect. Rev. 51. pp. 578–579, Oct. 3; and pp. 681–683, Oct. 17, 1902.)—This paper deals with the principal impurities in fresh water, the means of their detection and removal, and gives full directions for estimating the hardness of water by the soap test. [See also Abstracts Nos. 202, 2233 (1901), and 155, 1409, 1791 (1902).] F. J. R.

263. *Steam Turbine.* **E. H. Sniffin.** (Street Rly. Rev. 12. pp. 723–730; Discussion, pp. 716–719, Oct. 11, 1902. (Daily edition).)—The author quotes figures from several series of tests showing the economy of the steam turbine, and gives diagrams showing the floor-space, engine-room volume, area of buildings, and total cost for plants of various powers when turbines are to be used and when vertical engines are to be used. The paper is chiefly of a commercial character, with special reference to the Parsons type turbines manufactured by the Westinghouse Company. H. R. C.

Digitized by Google

INDUSTRIAL ELECTRO-CHEMISTRY AND GENERAL ELECTRICAL ENGINEERING.

264. *Aluminium as a Reducing and a Heat-producing Agent* **H. O. Hofman.** (Technology Quarterly, 15. pp. 93–104, June, 1902.)—The introduction is purely rudimentary, and summarises the characteristics of the principal reducing agents, giving comparisons with aluminium, in a tabular form, referring in particular to thermo-chemical figures. The Roessler-Edelmann process for the desilverisation of argentiferous lead by means of zinc and aluminium (a modification of Parkes' process), is briefly touched upon. A favourable effect of aluminium is seen in its use in galvanising. By adding 0·001 per cent. of aluminium to the zinc, a much more fluid bath results, a given weight of zinc coating 20 per cent. more surface. The sheets are brighter and keep their colour better. The effects small amounts of aluminium have on the different forms of iron are of great importance. It was discovered by Wittenstrom in the eighties that if 0·05 per cent. to 0·1 per cent. of aluminium were added to a charge of wrought iron heated to pastiness, the iron liquefied so that it could be poured. In making steel castings, an addition of 0·03 to 0·05 per cent. of aluminium has a very beneficial effect in reducing the small amount of iron oxides that are formed, especially in pouring, besides preventing the formation of blow-holes. The commercial use of aluminium as a reducing agent, is further exemplified in the plant of A. J. Rossi, of Buffalo, New York, for the reduction of titaniferous iron ores, who uses an electrical furnace of the well-known Siemens type. The alloys made show a range of from 10 to 75 per cent. titanium, 0·1 to 0·8 per cent. carbon, and 0·015 per cent. sulphur, while the slag assays 80 to 85 per cent. Al_2O_3, and contains 90 per cent. of the aluminium charged. Hall's aluminium process, and the later process of Dr. Hans Goldschmidt are also discussed, a table being given, with reference to the latter, showing the heat-balance in reducing ferric oxide. Although the main object in the Goldschmidt process has been the reduction of refractory metallic oxides, the process is being applied also, as a heat-producer for welding, soldering, annealing, &c. O. J. S.

265. *Electro-Galvanising.* **C. F. Burgess** and **C. Hambuechen.** (Elect. World and Engineer, 40. pp. 411–416, Sept. 13, 1902.)—This is a lengthy article discussing the theory and practice of the methods for coating iron with zinc by electrolysis. After an explanation of the origin of the term "galvanised" iron, the authors describe and point out the defects of the older "dipping" process. They claim for the electrolytic method the following advantages:—(1) Greater uniformity and density of the zinc coating. (2) Greater adhesion between zinc and iron. (3) Greater purity of the zinc coating. (4) Greater control over thickness of the deposit. (5) Applicability to tempered articles, such as springs, and to engraved plates, or screws. (6) Greater economy, a saving of 20 per cent. being claimed on the zinc employed. The disadvantages of the electrolytic process as compared with the older process are:—(1) Greater capital outlay, as the plant for a given output must be larger. (2) Greater trouble and expense in preparing the articles for the zinc coating. (3) Greater expenditure upon raw materials, as the zinc must be purer. The various patented electro-galvanising processes are divided into two classes, namely, those using soluble anodes and those

Digitized by Google

using insoluble anodes. In America the former are exclusively used, in England the latter. The respective advantages of lead and zinc anodes are next discussed at considerable length, and the use of additions to the electrolytic bath is then dealt with. The authors recommend the use of aluminium sulphate, or of ammonia alum, with the zinc sulphate, and they put forward the theory that the improved deposit of zinc obtained with this bath is due to the separation of ions of aluminium at the kathode, and to the deposition of zinc as the result of secondary or chemical action. They have proved that the coating of zinc obtained under such conditions contains no aluminium. The use of organic substances in the bath, which has also been patented in America, is not recommended unless a chemist is in charge of the installation. The use of "striking" solutions and methods of preparing the articles for the baths are next discussed. The authors recommend Stannous chloride for the former, and they prefer sand-blasting to pickling solutions for cleaning the iron articles. The improvements which are required and may be expected in the electro-galvanising processes relate to (1) Methods of handling the materials; (2) methods of maintaining the strength and composition of the baths; and (3) increase in the speed of deposition. J. B. C. K.

266. *Motor Meters.* **T. Bruger.** (Elektrotechn. Zeitschr. 28. pp. 581–584, July 8, 1902. Paper read before the 10th Jahresversammlung des Verbandes Deutscher Elektrotechniker at Düsseldorf.)—The author first discusses the means usually adopted to compensate for friction in motor meters, and describes a new method devised by himself, adapted to continuous-current meters. A magnet is pivoted horizontally and surrounded by two coils at right angles to each other. The main and shunt currents pass through these coils respectively, which are wound so as to have opposing effects on the magnet. This arrangement is brought into the field of the main meter coils, so that when the shunt-current only is passing the magnet places itself perpendicular to the main field, and so exerts no action on the armature. There is then no tendency for the meter to run on its shunt alone. When current passes through the meter, the magnet tends to place itself in the direction of the main field, and the coils surrounding it being so adjusted that with the smallest current to be measured, the action of the main and shunt coils is equal and opposite, the magnet is kept in the direction of the field of the main-meter coils by their action, and so exerts an auxiliary movement to counter-balance the friction. As the main current increases, the magnet turns away from the axial position, and its moment on the armature therefore diminishes as the current increases. This apparatus realises the ideal compensation by exerting an additional moment which is zero when no main current passes, a maximum with the smallest current to be measured, and which decreases as the load increases. The author next describes the construction of a meter so designed as to need no compensation for friction. He found that in motor meters the only important source of friction is at the commutator, and to avoid this he makes a commutator of three segments only, of the smallest possible diameter. The three armature coils are connected, one end of each to one segment and the other ends together. Three resistances are connected, one end of each to one segment and the other ends to the spindle. These resistances have 15 to 20 times the resistance of the armature coils. Current is led into the commutator at one brush only, and leaves the moving system at the upper pivot, on the rounded point of which rests a light spring. The author states that the meter gives

Digitized by Google

excellent results. Next he describes a meter on a new principle, making use of the increase in resistance of a bismuth spiral in a magnetic field. Six coils on the moving system are differentially wound in three pairs, each being in series with a bismuth spiral, and each pair being connected in parallel. If one pair are in the field of a driving magnet, while one of the corresponding bismuth spirals is in the field of another magnet, the differential action of the coils is thrown out of balance and the driving magnet exerts a turning moment on the pair. On completing half a turn the other bismuth spiral is in a field, and the differential action of the pair of coils is thrown out of balance in the opposite sense. An oscillating meter on the same principle is also described. G. H. B.

267. *Electrical Winding Machinery.* **C. Köttgen.** (Elektrotechn. Zeitschr. 23. pp. 601–607, July 10, 1902. Paper read before the meeting of the Verband Deutscher Elektrotechniker at Düsseldorf.)—The author here discusses the various proposals that have been made, with a view to dealing with the losses which arise out of starting and stopping the machinery. These losses are serious, seeing that the loads lifted are heavy and the speeds high; moreover, the motor has regularly to be started and stopped at very short intervals. [See also Abstract No. 47 (1903).] Most of the devices here mentioned are patented. The first, due to Kapp, is the series-parallel method; German patent No. 128,711. Seeing that many of the motors run at speeds of from 30 to 60 r.p.m., this expedient, requiring two motors, becomes very expensive. Batteries may be used, and German patent 104,016 describes a method by which, after each stoppage, a group of cells is moved from one end to the other of the battery. This somewhat equalises the discharge of the different cells, but necessitates complicated connections, and has other disadvantages. Another plan is to switch in groups of cells, starting from opposite ends on the up and down journeys, as the speed increases; and if the speed for passengers is fixed at half of that for goods, the two halves of the battery can be treated in the same way, and the speed correspondingly reduced. This method, described in German patents Nos. 129,049, and 129,493, has been applied at the Gelsenkirchen mines near Düsseldorf, to a winding machine lifting 4 tons at a speed of 20 m. per second, the battery being divided into four groups of cells. In this way, in combination with a certain amount of shunt regulation, the losses are reduced to about 16 per cent. of the amount they would otherwise reach, and form of course a much smaller proportion of the total useful work done. The battery gives 500 volts; but at each end there is a small group of cells, giving 50 volts, which are used for adjusting the stoppages with accuracy for the discharge of the waggons, and give a speed of about 1 m. a second. These end cells are exposed to heavier discharges than the rest, and are therefore specially and separately charged. The construction of the controller and the nature of the switching arrangements are fully described. Leonard's system proposes to raise the excitation of the shunt of the winding motor from zero to a maximum; German patent No. 77,266. Kammerer, in patent No. 122,777, proposes a differential motor, consisting of a fixed and a rotating magnet, each with its own armature, the two armatures being combined on another rotating portion of the machine and mounted on a hollow shaft. The winding machine is connected to the rotating magnet, which is set in motion by suitably varying the excitation of the two magnets, the armatures being permanently connected to the full working pressure. The losses arising from methods depending on the regulation of the excitation are worked

Digitized by Google

out graphically. For winding machines worked by polyphase motors, flywheels of considerable size are almost a necessity. W. H. S.

268. *Electrically Operated Bascule Bridge.* (West. Electn. 31. pp. 187–188, Sept. 20, 1902.)—A new type of Bascule Bridge has lately been erected over the south branch of the Chicago River at Ashland Avenue at a total cost of 133,000 dollars, including 41,000 dollars for superstructure and masonry. The centre span is 160 ft. long with a clear waterway of 140 ft. The two side spans are each 48 ft. long. The total width of the bridge is 60 ft. and it carries two street car trucks. Each side of the bridge is operated by two 38-h.p. direct-current 500-volt motors which raise the outer end of the forward section of each half and at the same time lower the forward end of the back section whose weight is arranged to nearly counterbalance the forward section. By means of bevel and spur gearing the motors drive double square-threaded steel screws, 7½ in. diameter and 80 ft. long, upon which travel sliding blocks or nuts to which are attached the back ends of the operating struts whose forward ends are attached to the forward section, of the bridge. These struts are 12 in. square, built up of channel irons. When tested without the brick flooring on the back section, and therefore somewhat out of balance, 84 h.p. were required on starting to open the bridge, falling to 9 h.p. when the forward section gets into motion. To lower the bridge 57 h.p. was required to start it downwards. Operating towers are provided on each half, and contain special controllers and pneumatic bridge-locking arrangements arranged to secure the right sequence of events. E. H. C.-H.

269. *Standard Voltage in the U.S. Navy.* **W. V. N. Powelson.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1333–1354; Discussion, pp. 1424–1432, Oct., 1902.)—In this paper the author minutely examines the reasons which led the Navy Department to change the standard voltage from 80 to 125 volts. The latter was adopted because machinery and lamps manufactured for that pressure could be purchased from stock, thus giving quick delivery and reducing the cost of the plant. Other voltages were considered, and the three-wire system with 160 volts between the outers was tried on two large battleships; the author shows, however, by means of numerous detailed tables, that the 125-volt standard enables an even greater economy in wiring to be effected than the three-wire system, while the other advantages of the latter are equally secured with the standard adopted. By rating the incandescent lamps at 123 volts, intermediate between 125 and 120—both popular voltages—a ready supply of lamps at low prices was ensured. The loss incurred in working the searchlights at the higher voltage, which was of importance when these constituted the principal consuming devices in the ship, is now insignificant compared with the total output. By using incandescent lamps of commercial voltage it has been made possible to narrow the specified limits of variation in voltage and efficiency without incurring increased expense. A. H. A.

270. *Electricity in the U.S. Navy.* **H. George.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1269–1318; Discussion, pp. 1424–1432, Oct., 1902.)—The author refers to the advantages of electricity for many purposes on warships, and shows how its applications grew in five years from a total of 7 watts per ton of displacement to 57. Battleships of 12,000 tons require generating plant of about 350 kw. each. The arrangement of the plant is discussed, and it is stated that in the new 16,000-ton battleships there will be two dynamo-

Digitized by Google

rooms at opposite ends of the vessel, each equipped with four generating sets of 100 kw. each. The evolution of the engines from horizontal belted types to the present cross-compound direct-coupled form is outlined, and the specifications in force are reproduced in full. The generating sets are required to run satisfactorily for two hours with 38½ per cent. overload, and the temperature rise is limited to 38½° C. above the surrounding air (which may be at 25° C.) after four hours' run at full load. Particulars and illustrations of recent sets are given. The generators are compound wound. The switch gear is arranged so that all the dynamo negatives are coupled to a common bus-bar, while the positives are connected with separate vertical bars, which cross five horizontal bars connected with the respective circuits. The connections between the vertical and horizontal bars are made by means of switches. All the apparatus required for the control of any one generator is fixed in a vertical line on the switchboard. Each motor or lighting circuit is provided with a double-pole switch and fuse; full particulars and drawings of the switch gear are given. All insulated conductors are enclosed in enamelled steel conduits. Separate circuits are used for searchlight, lighting, and power purposes, and the lighting circuits are divided into "Battle service" and "Lighting service." The conductors are insulated with pure and vulcanised rubber, taped and braided. Motors are used mainly for driving fans, ammunition hoists, boat cranes, and the turret-turning mechanism. The latter is operated on the Ward-Leonard system, a separate dynamo being required for the operation of each turret. Electricity is used for various signalling systems and for automatic fire alarms; special devices are—the general alarm bells and the solenoid whistle signals for closing the watertight doors, both of which are described. Drawings and particulars of the engine-room telegraphs, helm indicators, and other signalling apparatus are given in some detail. At night the Ardois system of signalling with incandescent lamps is used. The searchlight projectors are fitted with parabolic glass mirrors and horizontal carbon lamps, with hand and automatic control; the projectors are trained exclusively by hand. A. H. A.

271. *Ferranti Patent Voltmeter Resistance Cut-out.* (Elect. Rev. 51. pp. 693–694, Oct. 24, 1902.)—The need for a satisfactory protecting device for electrostatic voltmeters is emphasised by the experiences of engineers with badly designed switch gears, fitted with unreliable apparatus. The tendency for all instruments of this type to spark across the still and moving vanes necessitates the employment of some protecting device, but until recently no design sufficiently simple had been evolved. The fuse and resistance, inserted with a view to afford, protection in case of a "short," and the reduction of the spark-length to within safe limits, have caused trouble in operation, and this circumstance has led to the introduction of a neat form of cut-out and resistance combined, by Ferranti, Limited. The device proper consists of a thin glass tube, filled with water of a certain conductivity, and provided with a small hole near one end, covered with a piece of rubber tubing, thus forming a valve similar to that of a cycle tyre. Current is led in at the top and bottom of the tube by platinum wires, fused into the sides and connected to brass terminals slipped over the ends of the tube. Spring clips are fitted into a porcelain case, forming the holder for the complete device, plug contacts being provided to push into suitable sockets directly under the voltmeter mountings; the cut-out can be removed from the porcelain holder and replaced by another at any time if necessary.

Digitized by Google

When in use if a spark should occur for any reason inside the voltmeter, the water in the tube at once vaporises and is forced out through the valve, the circuit being then broken by the falling of the liquid. The device has been tested across the terminals of a 3,000-volt alternator without failing to break the circuit, and is now in successful operation in a number of E.H.T. stations in this country. W. E. W.

REFERENCES.

272. *Stranding of Conductors.* **P. Holitscher.** (Elektrotechn. Zeitschr. 23. pp. 673–675, July 31, 1902.)—The author considers the various methods of arranging the strands forming a conductor, and arrives at the conclusion that no stranded conductors should be tolerated in which the ratio of the cross-section of copper to total cross-section is below 70 per. cent. A. H.

273. *Turbine Development in America.* **A. C. Rice.** (Eng. News, 48. pp. 208–210, Sept. 18, 1902.)—This is a paper dealing historically with the development, restricted to America, of the turbine water-wheel. G. W. DE T.

274. *Electricity at the Covent Garden Opera House.* (Elect. Rev. 51. pp. 347–350, Aug. 29, 1902.)—This paper gives an illustrated description of the electrical scene-shifting arrangements and other applications of electrical power at the Royal Opera House. G. W. DE T.

275. *Notes on the Drainage Installation at the Mines of Kaiserstuhl and Firminy.* **W. Kummer.** (Soc. Belge. Élect., Bull. 19. pp. 433-436, June, 1902.) —Describes in detail the plant already mentioned in Abstract No. 179 (1903.) LL. B. A.

276. *Electric Locomotives for Mine Haulage.* **G. Gibbs.** (Cassier, 22. pp. 323–343, July, 1902.)—The author describes and illustrates the principal types of electric locomotives employed in mining work. He also discusses the methods of distribution giving the most economical results in different classes of mines. A 36-in. gauge is advocated in preference to narrower ones. The relative advantages of electric and compressed-air locomotives are discussed. G. W. DE T.

277. *Some Novelties in Electrical Apparatus.* **M. B. Field.** (Electrician, 49. pp. 946–948, Oct. 3, 1902. Paper read before Section G of the British Association at Belfast, Sept., 1902.)

278. *Electric Pumping in Great Britain.* **I. W. Chubb.** (Feilden, 7. pp. 295–304, Oct., 1902.)

279. *Electric Heating at Davos-Platz.* (Electricien, 23. pp. 182–184, Sept. 20, 1902.)—An account is given of electrical heating appliances, manufactured by Godin of Guise (France), and Helberger of Munich. O. J. S.

280. *Education of Electrical Engineers.* (Amer. Inst. Elect. Engin., Trans. 19. pp. 1175–1210, Aug.-Sept. 1902.) Discussion of papers dealt with in Abstracts Nos. 1967 (1902) and 62, 63, 64, and 185 (1903). G. W. DE T.

281. *Proposed Developments of the American Institute of Electrical Engineers.* **C. F. Scott.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1219–1230, Aug.-Sept., 1902.)—The inaugural presidential address. G. W. DE T.

282. *Civilian Co-operation in the Development of Electrical Devices for Military Purposes.* **C. D. Haskins.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1249–1252; Discussion, pp. 1424–1432, Oct., 1902.)

Digitized by Google

GENERATORS, MOTORS, AND TRANSFORMERS.

283. *Sparkless Commutation.* **F. Punga.** (Zeitschr. Elektrotechn. Wien, 20. pp. 366–369, July 27; 377–380, Aug. 3; and pp. 390–394, Aug. 10, 1902.)—After briefly reviewing the various theories of commutation, the author takes for his starting-point the following formula, due to Fischer-Hinnen :—

$$E_s = 2RI \frac{e^{\frac{RT}{L}} + 1}{e^{\frac{RT}{L}} - 1},$$

where E_s is the required reversing e.m.f. in a coil of resistance R and inductance L; I the original current in the coil, and T the time of reversal. In this formula the value of R is of very little importance, so that approximately $E_s = 2LI/T$. The author then proceeds to calculate the reversing e.m.f. due to uneven current density over the contact area of the brush, assuming that the density increases uniformly from zero at the heel to a maximum at the tip of the brush. The result of the investigation leads to the adoption of $F = \frac{E_s - E}{a e_m} \cdot i_m$ as a measure of the tendency of a machine to spark; E being the e.m.f. induced by the motion of the coil across the field, e_m and i_m the drop of potential and current density respectively over the contact area, on the assumption of uniform current-density; and a being a coefficient whose value depends on the number of segments covered by the brush ($a = 1$, $\frac{3}{4}$, $\frac{5}{8}$, and $\frac{7}{16}$ when the brush covers 1, 2, 3, and 4 segments respectively). Using the value of E_s given above, the formula becomes $F = \frac{2LI/T - E}{ar}$ (where $r = e_m/i_m$ = resistivity of brush contact area). This formula shows at a glance the conditions which tend to increase or reduce sparking. The author claims that this result is more general than the method used by Parshall and Hobart, which may be considered as a special case of the above. He shows how to apply the formula by working out fully a numerical example, and states as a result of experience that F should at full load have a value not exceeding 16 to 20 for carbon brushes. A. H.

284. *Field Distortion and Armature Reaction.* **R. Bauch.** (Elektrotechn. Zeitschr. 23. pp. 611–615, July 10, and pp. 624–630, July 17, 1902. Paper read before the 10 Jahresversammlung des Verbandes Deutscher Elektrotechniker in Düsseldorf.)—This paper contains an account of the various theories of armature reaction in continuous-current dynamos, three-phase generators, and rotary converters. The author supposes the air-gap field distribution to be produced by suitable surface distributions of magnetism over the pole-shoes and the armature core, such distributions being equivalent to the field and armature ampere-turns. Numerous field-distribution curves are given which show that the experimentally obtained values closely approach those furnished by theory. A. H.

285. *Squirrel-cage Rotors.* **M. Osnos.** (Zeitschr. Elektrotechn., Wien, 20. pp. 389–390, Aug. 10, 1902.)—The air-gap in induction motors being very

Digitized by Google

small, and the resistance of a squirrel-cage winding very low, the slightest want of symmetry in the magnetic field due to an eccentric position of the rotor core will give rise to relatively large equalising currents between the rotor bars lying under pole-pieces of like polarity. In order to limit these the author proposes to subdivide the short-circuiting rings into as many segments as there are pairs of poles in the stator. It will be sufficient to subdivide one ring only. A slightly different arrangement, constituting a sort of series-parallel connection, consists, in the case of a four-pole motor, for example, in bisecting each short-circuiting ring and arranging the bisecting diameters at 90° to each other. The insulation between the ring segments need not be very good, a coating of oxide being sufficient. The author mentions that this mode of construction has been independently devised by E. Ziehl and applied by him to induction motors with marked success. A. H

286. *Double-Current Generators and Rotary Converters.* **S. Woodfield.** (Elect. Rev. 51. pp. 569–571, Oct. 3, 1902.)—The objections usually raised against this class of machine, that it is difficult to start and to synchronise, and that it is liable to hunt, are purely imaginary. The latter difficulty is non-existent if the system is well designed, and the engines properly balanced, and fitted with dashpots to reduce the sensitiveness of the governors to small rapid fluctuations; and the method of starting up rotaries by means of a small auxiliary induction motor, running at a higher speed than the rotary, and then bringing the latter down to synchronous speed by loading one phase through a rheostat, makes synchronising an easy matter. Six distinct uses of the rotary converter are enumerated; in this paper the author deals chiefly with its employment as a double-current generator, giving both alternating and continuous power at the same time when mechanically driven. For railroad work, a double-current generator has the advantage over two separate machines that the load is automatically shifted from one side of the machine to the other without the efficiency being altered to any great extent. The question of cost is not so serious in this country as in America and on the Continent, where low-speed engines are in vogue. Spares also are reduced to a minimum, thus reducing capital cost. In a rotary used as a converter there is no distortion of field due to armature reaction; used as a double-current generator, however, the armature reaction is due to the sum of both currents, and the demagnetising action due to this cause may be so strong as to cause the machine to lose its excitation. For this reason it is often advisable to separately excite a double-current generator. Low frequency and high engine speed are both points which fit in well with the use of these machines, as under these conditions they may be designed with few poles, which means that the diameter can be kept within reasonable limits. After giving formulæ for the relations between the current, voltage, &c., on the alternating and continuous side, the author refers to the use of step-up transformers, which are necessary for the transmission of the alternating current, and of which the cost has to be added to that of the generators. As regards substations, induction motors coupled to direct-current generators are convenient, since no regulation is required on the alternating side. Further, the induction motor gives ample margin for temporary overload, and no transformers, starting motor, or synchronising gear being required, the wages of substation attendants can be cut down to a minimum. This, with the absence of hunting, is a good set-off against the better power factor and efficiency obtained with a synchronous set. In a

Digitized by Google

rotary converter substation the primary voltage on the transformer must be kept constant, and an induction regulator becomes necessary, which is preferably installed in the substation, on the high-tension side. B. P. S.

287. *Compensated Continuous-Current Generators.* **F. Eichberg.** (Elektrotechn. Zeitschr. 23. pp. 817–824, Sept. 11; Discussion, pp. 757–758, Aug. 21, 1902. Paper read before the 10 Jahresversammlung des Verbandes Deutscher Elektrotechniker in Düsseldorf, 1902.)—The arrangement described is one recently patented by Déri, and it closely resembles the designs proposed by Ryan and Fischer-Hinnen. The armature of the machine is of ordinary construction, but the field magnet takes the form of a hollow laminated cylinder resembling in every respect the stator of an induction motor. Two windings are distributed over the slots of the stator, their relative positions corresponding to those of the stator windings of a two-phase induction motor. One of these is the ordinary shunt field winding, connected across the brushes of the machine; the other is a series winding, which forms the balancing or compensating coils. The author states that an essential feature of the arrangement is the use of balancing coils which are *stronger* than the armature winding. This allows of any required final adjustment being effected by the use of a shunt across the balancing winding. Diagrams are given of different ways of arranging the two windings, and illustrations of the machine actually constructed, with tables and curves showing their performance. On account of the large polar arc (there being no interpolar gaps), a low induction in the air-gap is possible, and the corresponding low saturation of the core allows of an increase of field-strength of from 50 to 60 per cent., which is unattainable in machines of ordinary construction. The air-gap may be reduced to a mere mechanical clearance. The machines are said to be lighter and more efficient than those of ordinary construction. *Discussion:* **Arnold** expressed the opinion that probably a larger amount of copper would be required in the field coils than in those of ordinary machines. Déri's machines would, however, be useful in special cases, as the length of the armature could be increased considerably beyond the usual limits. **Ziehl** stated that there was an actual saving in the field copper; the shunt coil being required to supply only from 30 to 35 per cent. of the normal armature ampere-turns, the total field copper came to roughly 1·3 times the armature copper, as against 2 or 3 times the armature copper in ordinary machines. In his reply, **Eichberg** referred to actual data showing a saving in copper, and a reduction in the total weight of from 10 to 15 per cent. A. H.

288. *Asynchronous Generators.* (Elektrotechn. Zeitschr. 23. pp. 756–757, Aug. 21, 1902. Discussion on Heyland's paper. [See Abstract No. 2828 (1902)].)—**Görges** drew attention to some early experiments of his on the use of induction motors fitted with commutators. **Eichberg** pointed out that the use of shunts across the commutator segments presented a difficulty, since low-resistance shunts would reduce the starting-torque, while high-resistance ones would lower the efficiency at full load. **Ziehl** gave an account of the changes of speed taking place in a commutator motor as the brushes are moved into various positions. In his reply, **Heyland** referred to the method of running such machines in parallel as generators. One of the machines would be compounded, the others being simply compensated. The compounded machine would supply the entire wattless current, and when this exceeded a certain limit, another compounded machine would have to be put down.

Digitized by Google

Parallel running was as simple as with continuous-current shunt-wound generators. A. H.

289. *Heyland Single-Phase Motor.* (Electrician, 50. pp. 55–57, Oct. 31, 1902.)—The paper gives an illustrated description of a 150-h.p. single-phase induction motor fitted with Heyland's arrangement of starting coils [see Abstract No. 848 (1900)]. Both running and starting windings are wound drum fashion, the running winding being placed in half-open slots, and the starting winding in large square holes. The two windings are at starting connected in parallel across the mains, and when a certain speed has been reached the starting winding is cut out. The rotor has a three-phase star-connected drum-winding with slip-rings for inserting a starting resistance. Curves are given showing the torque, slip, efficiency, power-factor, and stator current corresponding to various loads. A. H.

290. *Starting Single-Phase Motors.* **A. Schwartz.** (Elektrotechn. Zeitschr. 23. pp. 795–798, Sept. 4, 1902.)—In a single-phase induction motor the reaction between the field and the currents in the end-rings of a short-circuit rotor, when starting, tend to push the rotor out of the field if it be only slightly displaced axially in either direction. When synchronism is nearly reached, however, the altered distribution of currents in the rotor cause this effect to cease and the rotor is drawn back to a symmetrical position by the magnetic attraction on the iron core. This action is utilised for three different purposes in the motor described. First, the rotor is displaced into such a position that its self-induction is sufficiently reduced to give the best conditions for starting. Secondly, the axial motion of the rotor is made to release a centrifugal coupling, thus putting on the load only when the motor has practically reached synchronism. Thirdly, by means of contact rings on the shaft the axial motion is made to switch out the auxiliary starting winding after the motor has started. A. E. L.

291. *Burnand Transformers.* (Electrician, 49. pp. 862–864, Sept. 19, 1902.)—The coils are of triangular cross-section, and are on four sides of an iron square built up of stampings. The advantages claimed are large cooling surface, small radial depth of coil, and shortness of electrical circuit without increase in length of magnetic circuit. There are diagrams to illustrate the manner in which the transformer is constructed. B. P. S.

292. *Practical Working of Rotary Converters.* **J. R. Salter.** (Elect. Rev. 51. pp. 663–665, Oct. 17, 1902.)—The author describes a station in which a rotary converter is used for running either as a direct-current generator, or as a three-phase 25-cycle alternator, in parallel with other machines. When supplied with direct current and delivering alternating, the speed is not held constant, as it is when the rotary receives current from an alternating circuit. The armature reaction due to lagging currents on the alternating side has a demagnetising effect on the field. As the field weakens, the lagging currents increase, and the effect becomes cumulative. To overcome this instability the fields are excited by a special generator driven by a three-phase motor from the alternating side. The exciter field is unsaturated at the normal e.m.f., so that any change in speed causes a much greater change in the e.m.f., which varies the field of the rotary and keeps the alternations constant independent of the nature and amount of the load. It was found

Digitized by Google

necessary, however, when running from the continuous-current side to reverse the series field winding, as the rotary fell out of step if the motor was run as a shunt machine. Photographs of the machines and diagrams of connections, including the connections for conducting a Hopkinson efficiency test on the rotaries, are given. F. B.

REFERENCES.

293. *Armature Core Discs for Continuous-current Machines.* **F. W. Davies.** (Elect. Rev. 51. pp. 300–303, Aug. 22, 1902.)—The author discusses the dimensions of core discs for various types of armatures, and gives the formulæ for determining the dimensions of the core, and the ratio of internal and external diameter, and a curve showing the number of armature sections for various diameters. R. B. R.

294. *Equipotential Connectors for Multiple Wave-Windings.* **E. J. Brunswick.** (Electricien, 23. pp. 1–6, July 5; 35–37, July 19; 49–54, July 26; 137–141, Aug. 30, and pp. 152–157, Sept. 6, 1902.)—The author gives a general sketch of the various forms of armature windings, followed by a detailed account of Arnold's recent work [see Abstract No. 1433 (1902)] in connection with the use of equalising connectors in multiple wave-wound armatures. A. H.

295. *500-kw. Three-phase Alternator.* (Elektrotechn. Zeitschr. 23. pp. 798–800, Sept. 4, 1902.)—Details are given of the design of this alternator, built by G. Ansaldo, of Cornigliano, for La Bufola, near Naples. It is steam-driven, runs at 92·5 r.p.m, and is the largest electrical machine yet built in Italy. A. E. L.

296. *Single-phase Alternators on Polyphase Circuits.* (Amer. Inst. Elect. Engin., Trans. 19. pp. 1146–1148, Aug.–Sept., 1902.)—This is a discussion on the paper dealt with in Abstract No. 2326 (1902). G. W. DE T.

297. *Graphical Determination of Starting and Regulating Resistances.* **G. J. Erlacher.** (Schweizerische Blätter für Elektrotechnik, 7. pp. 113–115, Aug. 8; and pp. 121–122, Aug. 22, 1902.)—The author describes a number of graphical methods for designing rheostats. One of these has already been fully noticed in Abstract No. 67 (1903). A. H.

298. *Calculation of Field Rheostats.* **E. Dick.** (Zeitschr. Elektrotechn., Wien, 20. pp. 401–402, Aug. 17, 1902.)—The author explains an approximate graphical method of determining the steps in the regulating resistance for a shunt-wound generator. A. H.

Digitized by Google

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

299. *Central Station Charging Systems and Rates in Use in U.S.A.* (Elect. World and Engineer, 40. pp. 361–366, Sept. 6, 1902.)—Owing to the interest aroused in the discussion of this subject at the Cincinnati Electric Light Convention inquiries were addressed by the editors of the Elect. World and Engineer to representative Electric Light Companies in every part of the States. The following details are taken from some of the more important replies received to this letter of inquiry :—*Cleveland (Ohio) Electric Illuminating Company:* In the spring of 1899 the company adopted the following system of charging, which for the three years it has been in force has proved entirely satisfactory both to the company and to the consumers—12½ cents per kw.-hour for 60 hours' use per month of all lamps connected, and 5 cents per kw.-hour for all current used in excess of this 60 hours. In January, 1901, the reduced rate was altered, so as to come into force for all current above 50 hours per month. *Edison Electric Illuminating Company of Boston:* The Wright, or maximum demand, system of charging has been in use by this company for three and a half years, and has given complete satisfaction. No details as to rates charged. *Augusta (Ga.) Railway and Electric Company:* The following system of charging was adopted three years ago—(1) A payment of 25 cents per month as matriculation fee. (2) 25 cents per month rental for each meter installed. (3) 25 cents per month for each 16-cp. lamp demand of current used or contracted for. (4) 4 cents per kw.-hour for all power registered by meter. The above prices are all subject to a discount of 10 per cent. if paid on or before the tenth day after the date of bill. No statement as to whether the system has been found satisfactory. *Fort Smith and Van Buren (Ark.) Light and Transit Company:* This company sells all current for lighting purposes by meter measurement. In the business district (Class A) the rates are much lower than in the residence district (Class B), where cost of distribution is greater. However, some consumers in the business district take a Class B rate, such as theatres and factories that operate very little at night, yet require a connection. Below is the schedule of rates for the two classes :—

	Class A. Cents per kw.-hour.	Class B. Cents per kw.-hour
Less than 5 kw.-hours	35	25
From 5 to 10 kw.-hours	30	20
„ 10 „ 15 „	25	20
„ 15 „ 20 „	20	20
„ 20 „ 25 „	15	18
„ 25 „ 50 „	10	18
„ 50 „ 75 „	9	15
„ 75 „ 100 „	8	15
„ 100 „ 300 „	7	12½
„ 300 „ 1,000 „	6	10
„ 1,000 or more „	5	—

The system has proved satisfactory on the whole. *Boulder (Colo.) Light and Power Company:* This company has always used a flat rate charge of 15 cents

Digitized by Google

per kw.-hour, with a discount for prompt payments. For small plants the manager considers this the best system. *Skowhegan (Me.) Electric Light Company:* This company charges on a sliding-scale system and charges the same for dwellings as for commercial lighting. No discount is allowed. For the first 15,000 watt-hours 10 cents per 1,000 watt-hours is charged, which puts the large consumer and the middle consumer on an equality with the small consumer up to that amount; for the next 15,000 watt-hours 8 cents per 1,000 watt-hours is charged, which places the large consumer on an equality with the middle consumer up to that amount. For over 30,000 watt-hours the charge is 5 cents per 1,000 watt-hours, which allows the large consumer during the winter season to get the additional lighting required at a minimum price. *South Jersey Gas, Electric and Traction Company:* The average yearly rate per kw.-hour for all consumers, including the few still preferring the straight 15-cent rate, has been a trifle over 10 cents. We have recently made, in special cases, a further reduction to a 14, 8, and 6-cent rate, the 6-cent rate being charged for all consumption above double the minimum charge. The arrangement will probably be made general in the near future. For power service we charge 10, 5, and 3 cents per kw.-hour. Ever since the adoption of this plan the business of the company has shown an uninterrupted and very healthy increase both in gross and net earnings. *Wyoming Valley Electric Light, Heat, and Power Company, Wilkesbarre, Pa.:* The rate of this company for incandescent lighting is on a sliding scale, starting with 10½ cents per kw.-hour up to 290 kw.-hours and diminishing 1 mill. with every succeeding 20 kw.-hours up to 600 kw.-hours; 40 kw.-hours up to 1,000 kw.-hours; and 80 kw.-hours up to 2,000 kw.-hours. The rate on current for motors is 10½ cents per kw.-hour up to 80 kw.-hours and diminishes 1 mill. with every succeeding 5 kw.-hours up to 100 kw.-hours; 10 kw.-hours up to 500 kw.-hours; and 20 kw.-hours up to 720 kw.-hours. The following discounts are allowed off incandescent light and motor bills if paid on or before the last discount day as specified on the bill: 6 per cent off on bills up to $28·35 inclusive, and 5 per cent. off on bills over $28·35. *The New Omaha (Neb.) Thomson-Houston Electric Light Company:* As will be noted from the following schedule, the discounts for incandescent light are based on the total consumption of each 16-c.p. lamp per month. The basic rate lighting service is 15 cents per kw.-hour, with free renewals, subject to the following discounts on monthly bills: Up to 2 kw.-hours, 10 per cent.; 3·5 kw.-hours, 20 per cent.; 7 kw.-hours, 30 per cent.; 15 kw.-hours, 40 per cent.; over 15 kw.-hours, 50 per cent. As stated above, an arc lamp is considered the equivalent of eight incandescent lamps, and a charge of 50 cents per month is added for the loan of an arc lamp. For power, the basic rate is 10 cents per kw.-hour, with discounts on monthly bills ranging from 10 per cent. for 200 kw.-hours; 30 per cent. for 600 kw.-hours, to 50 per cent. for over 900 kw.-hours. The minimum charge is $3 per month. *Edison Illuminating Company of Detroit:* In annual contracts covering all classes of service when the customer guarantees 30 hours' use per month of the demand, the rate of the first 30 hours is 16 cents per kw.-hour and thereafter 5 cents per kw.-hour. For incandescent lighting on open order with no guarantee, the first 60 hours' use monthly of connected load is at the rate of 16 cents, and thereafter 5 cents per kw.-hour. For residence lighting, which is taken on open order and with a demand estimated empirically according to the size of the house, the first 30 hours' use monthly of the estimated demand is at

Digitized by Google

the rate of 16 cents, and thereafter 5 cents per kw.-hour. For power, intermittent, the rate is 10 cents for the first 80 hours' use monthly of the rated capacity of the motor, and thereafter at 5 cents per kw.-hour. For power, continuous during regular shop hours not less than 48 hours per week, 5 cents per kw.-hour. *The Harrisburg (Pa.) Light, Heat, and Power Company:* The rates are 15 cents per 1,000 watt-hours, subject to the following discounts: On bills from $1 to $20, 5 per cent.; from $20 to $50, 10 per cent.; from $50 to $75, 15 per cent.; from $75 to $100, 20 per cent.; from $100 and over, 25 per cent. *Charleston (S. C.) Consolidated Railway, Gas, and Electric Company:* After careful investigation of the various systems of charging for light and power then in vogue, this company, in 1899, deemed it advisable to adopt the following system of charging: The rate for incandescent lighting is 15 cents per kw.-hour, with discounts on bills, as follows: $11 to $20, 8 per cent.; $21 to $40, 5 per cent.; $41 to $80, 7 per cent.; $81 to $160, 10 per cent. For larger amounts, the discounts gradually increase to 25 and 10 per cent. for bills of $600 and over. *The Poughkeepsie (New York) Light, Heat and Power Company:* The rates charged by this company are as follows: Lighting, 15 cents per kw.-hour with discounts varying from 5 per cent. to 35 per cent., according to quantity. The price for power is 10 cents per kw.-hour with discounts varying likewise from 5 per cent. to 35 per cent. Much of our business is done at special rates. In addition to the above replies were received from the New York and Steten Island Electric Company, the Phœnix (Arizona) Light and Fuel Company, the Columbus (Ohio) Edison Company, the New Orleans and Carrolton Railway Light and Power Company, the Topeka (Kan.) Edison Electric Illuminating Company, and from the Rochester (New York) Gas and Electric Company, but for various reasons these replies are not adapted for abstracting. J. B. C. K.

300. *Physical Limits of Electric Power Transmission.* **A. D. Adams.** (Eng. Mag. 24. pp. 10–16, Oct., 1902.)—The author points out that alternate-current generators of the revolving magnet type with stationary armature windings have been constructed to work at pressures up to 13,000 volts. The thickness of insulating material required makes the dimensions of such machines large in proportion to their output, but their use makes it practicable to dispense with step-up transformers for transmission up to somewhat over 80 miles. With regard to long-distance transmission, he suggests that, to obviate leakage between the different phases, which becomes of importance at high pressures, separate poles should be provided for each phase in cases where the present maximum pressures of 50,000 to 60,000 volts are to be greatly exceeded. G. W. DE T.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

301. *Manchester Corporation Electricity Works Extension.* (Electrician, 49. pp. 252–259, June 6, 1902.)—This article consists of a complete description with illustrations of the buildings and plant erected in connection with the Stuart Street extension of the Manchester Electricity Supply Works [see Abstract No. 1594 (1901)]. With the completion of this plant the total h.p. available at the various works will be 58,000 i.h.p., requiring 360 miles of cable for transmitting the current generated. Of this power current will be required for 800 cars and half a million 8-c.p. incandescent lamps. J. G.

Digitized by Google

302. *Champ Electric Generating Station.* **Lépine.** (Soc. Int. Élect., Bull. 2. pp. 659–677, Aug.–Sept.–Oct., 1902.)—This is an electric station driven by water-power, and the author gives very full details of the hydraulic work, together with photographs of the work in progress and completed. The water is taken from the river Drac, which rises in the High Alps. The flow is very irregular, varying from 20 c.m. per second at low water to 1,200 at high water. The average fall within 20 km. of Champ is 7 per cent. The water is conducted to the generating station in a specially built tube, 4,600 km. long by 3·3 m. in diameter. The theoretical head available is 87·4 m., of which 5·4 m. is lost in the pipe line, leaving 82 m. available. The mass of moving water in the tube is 40,000 c.m., travelling at a rate of 2 m. a second. In order to prevent hydraulic shock, due to the shutting down of the works, three standpipes are erected at certain points in the pipe line. That near the station is 35 m. high, tapering from 3·3 m. in diameter at the base to 1·4 m. at the top, where a steel tank is fixed 3 m. in diameter by 2 m. deep. From this three downcomers, each of 0·6 m. diameter, fixed on the outside of the standpipe, discharge into the tail-race. The power-house contains five sets of three-phase turbine-alternators, each of 1,850 h.p., two sets of turbine exciters, each of 150 h.p., and a 5-h.p. turbine to charge the two hydraulic accumulators used for operating the automatic regulator. The turbines are of the horizontal type, running at 300 r.p.m., and coupled to the alternators by means of elastic couplings. At full load the turbines take 3 c.m. of water per second. The alternators are by Brown, Boveri & Co.; they are of the horizontal shaft revolving field type, capable of absorbing 1,350 h.p. when $\cos \phi = 0{\cdot}8$. The number of poles is 20, the periodicity 50, and the voltage 3,000. The fixed armature is "Star" connected. There are five step-up transformers, each having a capacity of 115 kilo-volt-amperes. They may be changed from "Star" to "Mesh" connection at will in order to obtain either 26,000 or 15,000 volts on the secondaries. The alternators, with power-factor unity, have an efficiency of 94·5 per cent., and of 93·8 per cent. with a power-factor of 0·8. The efficiency of the transformers at full load is 97·8 per cent., and at half load, 97 per cent. The voltage drop in the alternators is 4·7 per cent., 13 per cent. and 15 per cent. for power-factors of 1, 0·8, and 0·7 respectively. For the transformers, 1 per cent. and 1·5 per cent. for power-factors of 1 and 0·8 respectively. The current is distributed at 26,000 volts to 11 substations, where it is reduced to 2,000 or 1,000 volts according to the locality. The main switchboard, the overhead conductors and method of support are described and illustrated. The total efficiency of the whole system is 58 per cent., made up thus: Turbines, 76; alternators, 94; transformers, 97·5; line, 94; transformers and secondary lines, 90 per cent. F. B.

303. *Sault Ste. Marie Water-Power.* **F. C. Perkins.** (Elect. World and Engineer, 40. pp. 483–485, Sept. 27, 1902.)—This article describes and illustrates the great canal, power-house, and hydraulic installation for the Transmission of Electrical Energy by "The Michigan Lake Superior Power Company." The area of Lake Superior is about 80,000 square miles, and it is fed by an immense watershed. The discharge from the lake so fluctuates with the conditions of evaporation, &c., that the quantity which passes the Sault Rapids varies from 8,000,000 to 7,000,000 cub. ft. per minute. This represents a total of from 100,000 to 250,000 available h.p. The canal which leads the water to the hydraulic plant is about $2\frac{1}{3}$ miles long, with a normal width of 220 ft. and depth of 22 ft. In the power station there are

Digitized by Google

320 turbines, divided into groups of four; thus making 80 units of four 83-in. turbines with two pairs to each shaft. Each unit, under normal conditions, takes 391 cub. ft. of water per sec. under an effective head of 16 ft., and is rated to give 568 h.p. with a maximum efficiency of 81 to 82 per cent. Each of these 80 units operates a 400-kw. generator, to supply electrical power for various manufacturing industries. The paper is accompanied by a map showing a corner of Lake Superior, the Rapids, St. Mary's River, and the full length of the canal; by a photo view of the Canal, the Head Gates, the Timber Lined Canal, the Ice Rack, and the Hydraulic Equipment. A. J.

304. *New York Shipbuilding Company's Electric Plant.* **J. B. O'Hara.** (Cassier, 22. pp. 117–136, June, 1902.)—The shops employ direct-current enclosed arc lamps for lighting the yards and shops, direct-current motors for operating cranes, and alternate-current motors for driving machine tools. To meet these requirements, two double-current, direct-connected, 500-kw., Westinghouse generators, running at 120 r.p.m., are employed, delivering current at 250 volts. The proportion of alternating to direct current delivered is automatically regulated by the demands of the works. A number of heavy electrically operated tools are illustrated and described. G. W. DE T.

305. *West Bromwich Electricity Works and Tramways.* (Elect. Engin. 30. pp. 479–483, Oct. 3; and pp. 513–517, Oct 10, 1902.)—System: Direct-current three-wire for lighting, at 2 × 230 volts; 500 to 560 volts for traction. The boiler-room contains four multitubular boilers, of the dry-back type, fitted with superheaters and mechanical stokers. The engine-room contains two steam turbo-dynamos of 100 kw. each, and a balancing steam-dynamo of 50 kw., with a condensing plant capable of dealing with 10,000 lbs. of steam per hour. Two additional turbo-dynamos of 200 to 250 kw. each, with condensers, are to be installed, as well as a reversible booster and a negative booster. The feeders and distributors are laid in earthenware troughs, filled up solid with compound. The station is equipped with a storage battery of 236 cells. The equivalent of 7,196 8-c.p. lamps is connected. The price charged is 4½d. and 1½d. on the maximum demand system for lighting, and 1d. per unit for power. The tramways are equipped on the overhead trolley system; the steel poles spaced about 110 ft. apart, carry, by means of bracket arms in some places and span wires in others, two hard-drawn copper trolley wires of No. 000 S.W.G., insulated by composition in gun-metal fittings. The rails are of the girder type, weighing 97½ lbs. per yard, and are tied together by iron ties. The fishplates are of steel, with anchor joints made with sections of steel joist, and the joints are bonded with Neptune bonds of No. 000 gauge, two to each joint. The foundation of the track is of concrete, 6 in. thick. The track is paved with granite setts and wood blocks. Drawings: The article is fully illustrated with drawings and photographs. A. H. A.

306. *Marseilles Electric Tramways.* **H. Dubs.** (Génie Civil, 41. 1. pp. 229–236, Aug. 9, 1902.)—The Marseilles Tramways have a total length of about 125 km., with a great concentration of traffic along some of the central streets. The power is supplied from a generating station on the banks of the river Huveaune, at a distance of about 5 km. from the centre of the town. The boiler-house contains 20 semi-tubular boilers arranged in four groups, with a Green economiser to each group. Water is supplied by means of four duplex

Digitized by Google

pumps driven by an electric motor. A Desrumeaux water softener is employed. There are two chimneys 60 m. high, and with openings at the top 3·2 m. in diameter. The boilers are arranged on the ring system, and so that each engine can receive its supply of steam either from the boiler from the right or left, so that repairs to the steam piping can be carried out without stopping any of the engines. The engine-room contains five 1,000-kw. generating units, three exciting units, and the switchboard. Each generating unit consists of (1) a Corliss horizontal, compound, condensing engine, running at 75 r.p.m. and developing normally 16,070 i.h.p. The diameters of the cylinders are 0·9 m. and 1·5 m. respectively, and the length of stroke is 1·4 m. The governor is capable of adjustment by means of a movable counterpoise actuated by a screw. This adjustment can be effected whilst running either by hand or by means of a motor operated from the switchboard. The shaft carries a 36-ton flywheel in addition to the inductor of the alternator, which weighs 32 tons. The coefficient of variation during the stroke is 1/380 when developing its normal power. (2) A direct-connected inductor three-phase, 5,500-volt, 40-pole 1,250-kw. alternator producing current at 25 ∿ . They are capable of carrying an overload of 25 per cent. for two hours, or 50 per cent. for two hours. Each exciting unit consists of (1) a compound, condensing engine of 120 i.h.p., running at 210 r.p.m.; (2) a direct-connected, 4-pole dynamo of the external armature type. There are six substations, each arranged to accommodate four units consisting of a three-phase step-down transformer made up of three distinct single-phase transformers and a six-phase rotary converter, consisting of a dynamo with external poles. Six-phase converters were used in preference to three-phase in consequence of their greater output, viz., 1·45 : 1. The 400-kw. converters have 8 poles and run at 375 r.p.m., whilst those at 25 kw. have 6 poles and run at 500 r.p.m. The units as yet installed in the substations are two each in four of them and three in each of the two remaining ones. The current is supplied from the substations to the lines, which are all on the overhead trolley system, at the usual pressure of 550 volts. The high-pressure cables are armoured and are laid directly in trenches 0·8 m. in depth. They rest on sand, and are protected from accidental damage by a covering layer of bricks. The energy loss between the central station and the substation does not exceed 3 per cent. at normal load, and 5 per cent. at a 50 per cent. overload. The coal consumption per kw. delivered at the switchboard was guaranteed not to exceed 1·2 kg. at the normal output. The actual result obtained is somewhat better than this, viz., 1·048 kg. The combined full-load efficiency of alternators, high-pressure feeders, transformers, and converters is 0·865, and the efficiency under running conditions is found to vary from 78 to 82 per cent. The total daily output is from 30,000 to 40,000 kw.-hours. The paper contains a number of illustrations, plans, and detailed drawings. G. W. DE T.

307. *Leeds Lighting and Power Station.* (Electrician, 50. pp. 51–54, Oct. 31, 1902.)—System two-phase. The boiler-room contains 8 Babcock boilers, each having 4,300 sq. ft. heating surface with superheaters, purifiers, Meldrum's coking stokers, and forced draught. The feed-water is heated by a 960-tube Green economiser. Coal and ashes are mechanically handled by a plant capable of dealing with 40 tons per hour. The engine-room contains two 2,400-h.p. triple expansion enclosed engines with forced lubrication. One is by McLaren, has cylinders 27·5, 39·5, and 65·5 in. diameter with 24-in. stroke, runs at 200 r.p.m., has trick-ported slide valves balanced horizontally and vertically, has automatic expansion governor, is 20 ft. high,

Digitized by Google

and covers 24 ft. by 9 ft. floor space. The other is by Belliss, and has cylinders 22·5, 35, and 55 in. diameter with 30-in. stroke, runs at 200 r.p.m., has piston valves and throttle governor, is 22 ft. high, and occupies 25 ft. by 8 ft. floor space. Two Cole, Marchant, and Morley surface condensers, each having 3,400 sq. ft. heating surface, are provided. Steam pipes are lap-welded steel with flanges welded on. Exhaust pipes are wrought iron riveted. Other pipes are cast iron. A Holden and Brooke oil separator is used. A 30-ton traveller is provided with a two-phase motor. The switch-board is by Ferranti, with oil-break switches. There are large cable subways. Each engine drives an E.C.C. two-phase alternator with 30-pole revolving field, giving a maximum of 1,750 kilo-volt-amperes at 2,200 volts on a load with power-factor 0·8. The flywheel effect reduces the fluctuation in velocity during a revolution to less than 1/20 of 1 per cent. from the mean, and when paralleling, synchronising current is almost nil. Commercial efficiency is guaranteed 95 per cent. at half load. The maximum allowable voltage drop from no load to full load is 4 per cent. if non-inductive, or 12 per cent. with a power-factor of 0·8. When one phase is carrying full non-inductive load, and the other is on open circuit, the difference in voltage of the two phases is not to exceed 3½ per cent. The frequency is 50. The magnets are 13·5 ft. diameter, and, with shaft and wheel, weigh 28 tons. The armatures are slot-wound. 8-kw. exciters are mounted on each alternator shaft. The substation transformers have outputs of 60 kw., with primaries wound for 3,000 volts, 50 periods and secondaries for 305 or 410 volts. Circular stampings give low magnetic resistance, and the open-circuit loss is 460 watts. The drop in voltage from no load to full non-inductive load is 1 per cent., while with a power-factor of 0·75 the drop is under 2 per cent. The equivalent of over 200,000 8-c.p. lamps is connected. The price charged is 4d., less 5 per cent. per unit for lighting, and 1½d. to 2d., less 5 per cent. per unit for power. E. H. C.-H.

308. *Power Transmission Plant at Portsmouth, U.S.A.* (Elect. World and Engineer, 40. pp. 569–576, Oct. 11, 1902.)—Power is generated at Portsmouth, on the coast of New Hampshire, with steam plant, and transmitted over distances up to 50 miles at 13,200 volts for traction, light, and power. There are in all 80·3 miles of high-pressure line, carried on chestnut poles 35 ft. long and 100 ft. apart. The conductors are spaced 15 in. apart, forming two triangles on each post, and are mostly of copper, though some are of aluminium; the insulators are porcelain, carried on two cross-arms. One of the high-pressure lines crosses an arm of the sea by means of a lead-covered submarine cable 1 mile long. Transfer switch houses, equipped with oil-break switches, are built wherever a junction of two or more lines occurs, and at each substation the power can be cut off from all the lines beyond it. There are nine substations, containing 45 transformers aggregating 5,010 kw., and 15 rotary converters giving direct current at 600 volts; one of these substations is portable, being contained in a box-car running on the electric railways. All these substations are used solely for operating the railways of the New Hampshire Traction Company, which owns the whole system. The total length of line is about 132 miles, of which 27 miles are on private property. A bridge 1 mile long carries the railway over the Hampton River. In cities the rails used weigh 90 lbs. per yard; elsewhere they are 70 lbs., usually 60 ft. long, and double bonded with 0000 bonds. The trolley wire is of 00 copper, mainly on side brackets, the poles carrying the feeders also. The rolling stock includes 140 cars. Light and power

Digitized by Google

supply is a minor branch of the business. Arc and incandescent lamps in series are used for street lighting, the former being of the enclosed type; constant-current transformers control the arc circuits, some of which work at 6,000 volts. The series incandescent lamps take 1·75 amperes at 50 volts, giving 25 c.p. each, on a 4,000-volt circuit; some are of 32 c.p., in series with the arcs, and take 6·6 amperes. There are in all 197 arcs and 275 incandescent lamps in use in this way, as well as 21,600 16-c.p. lamps for private lighting. The general supply is at 2,300 volts, two-phase, at 60 cycles per second, but there are several systems in use, including direct current for motors. There are two generators of 200 kw. each, 2,300 volts two-phase, 60 cycles per second, in the Portsmouth station; one of these is driven by a single-acting compound vertical engine at 288 r.p.m., while the other is driven from the 13,200-volt mains at 500 r.p.m. by a synchronous motor. The main generators are two in number, each rated at 1,000 kw., 13,200 volts three-phase, 25 cycles per second. Each is driven direct by a cross-compound horizontal engine, with cylinders 28 and 54 in. in diameter and 48-in. stroke, running at 94 r.p.m. The generators are of the revolving magnet type, generating direct at 13,200 volts. A third generator, of 2,000-kw. output, is on order; this will be coupled to a compound vertical engine, with cylinders 38 and 76 in. in diameter, stroke 54 in., running at 88·8 r.p.m. The main switchboard occupies a space 33 ft. high and 48 ft. wide. The 13,200-volt bus-bars are of bare copper strip carried on porcelain insulators in the basement; the switch gear is enclosed in compartments of brick and stone, and comprises 36 panels. The high-pressure oil switches are operated by electric motors, which are controlled by automatic relays also, so as to open the circuit in case of overloads on the feeders, after the manner of circuit breakers. Each generator panel carries volt and ampere meters, power-factor indicator, Lincoln synchroniser, and indicating and integrating wattmeters. Each feeder panel is fitted with three ammeters and two integrating wattmeters. There are three sets of three-phase feeders leaving the station; each line conductor is provided with a series of lightning arresters.

All the engines exhaust into a central condensing system. The steam pressure is 160 lbs. per sq. in. There are six boilers, of the horizontal tubular type, provided with superheaters and mechanical stokers. An economiser with 10,400 sq. ft. of heating surface is provided, and in addition to a chimney 150 ft. high, draught is induced by two 15-ft. fans. Feed-water heaters with 1,300 sq. ft. surface are installed; the water is derived from the city mains, and is fed to the boilers by compound steam pumps. Sea water is used for condensing. The power station building is practically fireproof. Special arrangements are made for leading the high-pressure conductors into the buildings. The article is well illustrated. A. H. A.

309. *Power Transmission at Springfield, Massachusetts.* (Elect. World and Engineer, 40. pp. 357–359, Sept. 6, 1902.)—The water-power station which has been constructed at the Birchem Bend on the Chicopee River, in order to supplement the steam power already existing in Springfield, is here described. The fall is 14 ft. high. The turbines are mounted in their cases directly on the floor of the canal, and their shafts are passed through the wall of the power-house in watertight stuffing boxes. They are directly coupled to 400-kw. two-phase 6,000-volt 60-cycle generators, running at 180 r.p.m. The power is transmitted to Springfield and is there distributed, partly by alternate current and partly by direct current, through asynchronous motor-generators.

W. H. S.

Digitized by Google

310. *Electricity Works of the Boleo Copper Mines, Mexico.* **E. Hoffmann.** (Génie Civil, 41. pp. 341–343, Sept. 27, 1902. This plant has already been described [see Abstract No. 372 (1900).]—The present article describes the generating plant, and gives further particulars of the mining machinery. The total capacity of the generating plant is 1,500 h.p., and that of the motors used in the mine is 1,680 h.p., in addition to the power used for lighting the town of Santa Rosalia. A locomotive capable of hauling 14 tons up an incline of 12 per cent., at a speed of 9 km. per hour, is equipped with a three-phase motor of 18 h.p., and runs on a track of 50 cm. gauge. There is a goliath crane of 9·2 m. span, capable of lifting 2 tons to a height of 7 m.; this is driven by three motors—one of 18 h.p. for lifting, one of 6 h.p. for travelling, and a third of 2 h.p. for traversing. Twenty windlasses of various powers, up to 2·4 tons, are installed, all driven by three-phase motors. A. H. A.

311. *Power Plant of Park Row Building, New York.* (Power, N.Y. 22. pp. 1–5, Oct., 1902.)—A description is given of the installation used for lighting this building, which contains 31 stories and is 390 ft. high. The plant includes three 300-h.p. Babcock boilers, two dynamos of 200-kw. capacity, one of 100 kw., and one of 75 kw., giving outputs at 120 volts. There is also a battery of accumulators, giving about 24 kw. for 10 hours. W. H. S.

312. *Power Plant in Antwerp Steel Works.* (Elect. World and Engineer, 40. pp. 621–622, Oct. 18, 1902.)—A large establishment near Antwerp, comprising blast-furnaces, steel works, rolling mills, and tube works, is equipped with a Westinghouse power plant which will eventually have a capacity of 30,000 h.p. There are at present two steam-driven sets consisting of 900-kw. three-phase alternators, giving 50 cycles and 2,200 volts and driven at 187 r.p.m. by triple-expansion marine type engines. Future extensions will be made with gas plant. The plant is run on two independent sets of bus-bars so as to keep the rolling mill separate from the other circuits. There are four transformer stations in various parts of the works. Induction motors of 325 and 450 h.p. for the rolling mills are supplied directly at the high tension and are provided with controllers similar to those used for electric traction for reducing the speed by about 25 per cent. by means of resistances in the rotor circuits. A. E. L.

313. *Warrington Electric Tramways.* (Tram. Rly. World, 12. pp. 395–400, Sept., 1902.)—When completed, the system will comprise a track length of 9¾ miles. The bed is made of 5 in. of 6 to 1 concrete and 1 in. of 3 to 1, over this being ¾ in. sand and then 5-in. setts. The rails weigh 90 lbs. per yard, and the anchor joints are formed of 2-ft. lengths, inverted and placed below the rails, to which they are securely bolted. Effective bonding is provided by means of one 0000 flexible bond and one Edison plastic bond. The cars are by Milnes on Brill trucks with Thomson-Houston equipments and Tidswell brakes. For line-signalling purposes each car is provided with an oil lamp which on a single line shows a red light, on a turn out a white light, and on a double line a green light. The boilers are by Babcock and Wilcox, engines by Willans, and dynamos by Bruce Peebles and The English Manufacturing Company. The switchboard is by Kelvin and James White, and there is a battery of 262 chloride cells, of 800 ampere-hour capacity, charged from the combined balancer-booster. The pumps for air and water are by Cole, Marchant, and Morley, and the condenser, of the barometric class, is by Klein. It consists of a vertical iron tube about 18 in. in diameter, the upper part

Digitized by Google

being 4 ft. wider than the trunk. Exhaust steam ascends and is met by a shower of water falling through a perforated plate at the top. A separate small condensing apparatus yields a supply of pure distilled water for replenishing the cells. The cables for both lighting and traction are B.I.W. concentric paper-covered, and are drawn into Sykes earthenware conduits. A good deal of energy for power is being supplied to the various small industries, and the charge is 2d. per unit per quarter year for the first 3,000 units, and 1d. per unit in excess of that amount. Current for lighting is charged at 6d. per unit for the first hour and 3d. afterwards; church lighting is charged at a uniform rate of 3½d. E. K. S.

314. *Rothsay Electric Tramways.* (Tram. Rly. World, 12. pp. 489–494, Oct. 9, 1902.)—This article gives an account of the new short tramway system by aid of a good "General View of Rothsay Bay and Pier"; a "Map of the Present Line with Authorised Extension to Ettric Bay"; two perspective views of the "Interior of the Engine-Room"; a "Cross-Section of the Permanent Way," with a separate "Section of the Rail"; a "View of the Line to Port-Bannatyne"; the "Span-Wire Construction at Skeoch Wood," and a view of an "Open Summer Car for Seating Fifty Passengers." The present line consists approximately of 2½ miles of double track, with numerous easy curves and a maximum gradient of 1 in 80 for only 200 yards. The permanent way is of the usual standard type, having a 3 ft. 6 in. gauge, with grooved girder rails weighing 97 lbs. per yard, in average lengths of 45 feet, laid upon a solid bed of concrete from 6 in. to 8 in. deep. The surface between and at the outer sides of the rails, is finished off with 6 in. by 4 in. Scotch granite setts, grouted with granite chips and bitumen. The margins at the roadsides, between this stone paving and the kerbs, are covered with tar macadam put down in three layers upon hand-pitched bottoming, except where these margins are narrow, and there they are also paved with either granite or whin setts on sand. Double "Neptune" rail bonds are used at each rail-joint. The overhead equipment is of the span-wire type throughout, with each of the two trolley wires suspended above the middle of its own track. The power-house is placed approximately in the centre of the present 2½-mile length of the tram-line, and thus the two trolley wires serve to convey all the current for ordinary working. They are connected to the switch-board by two short copper cables, each ¾ of a sq. in. in cross-section, covered with paper and sheathed with lead. The steam plant consists of two water-tube boilers, each rated for 250 h.p., and fitted with automatic stokers, an economiser, a feed-water heater, and pumps. The generating plant is divided into two sets. One of these consists of a horizontal compound engine driving a directly coupled 200-kw. 8-pole continuous-current generator, and the other a vertical compound engine coupled to a 150-kw. 4-pole generator. The larger of these is fully required for the summer traffic, whilst the smaller set is sufficient for the spring and autumn seasons. Besides these engines and dynamos there is a large battery of storage cells, having an output of 350 ampere-hours. The rolling stock at present comprises 10 open single-deck cars and 5 single-deck combination ones. Each car is provided with double trucks of the maximum traction type. They weigh about 10 tons without passengers, and have a total length of 43 ft. 6 in., with an overall width of 6 ft. 6 in. The open cars are seated for 50, and the combination ones for 46 passengers. This short seaside line is much more appreciated by both residents and visitors than the former horse-worked tramway line.

A. J.

Digitized by Google

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

315. *A 10,000-volt High-speed Locomotive.* **W. Reichel.** (Elektrotechn. Zeitschr. 28. pp. 685–691, Aug. 7, 1902.)—The locomotive built by Siemens and Halske for the experiments on the military railway near Berlin, has reached a speed of 160 km. an hour. The highest voltage yet applied is 15,000 at no load, and 13,800 at full load. For speeds of 150 km. an hour, the track did not appear to be sufficiently firm, the rails weighing 38 kg. per metre; consequently higher speeds than this have not been properly tested. This defect is to be rectified. The electrical equipment of the original locomotive was in every way successful; but the weight appeared excessive. The present article describes a new one which has been built; it has no transformers, the pressure of 10,000 volts being applied directly to the motors. The total weight of the train is thereby reduced from 96 to 76 tons, and the four motors give a maximum output of 400 h.p. each at 885 r.p.m. The locomotive is constructed with two bogies, on each of which two of the motors are mounted, the axles being connected to the motors by toothed gearing in the ratio of 1 to 2. The brakes are worked by pneumatic pressure on the Westinghouse system. The total length is 12·5 m., and the breadth 2·8 m. The driver's room is in the middle of the length, and the ends of the locomotive are covered with sheet-iron covers, which can be lifted for purposes of inspection. The whole with electrical equipment weighs 40,000 kg., the motors weighing about 16,000 kg. Each motor drives a separate axle, being connected to the axle by toothed gearing at each end, *i.e.*, each motor is placed on its spindle between two-toothed wheels, which gear with corresponding wheels on the axle. This arrangement secures symmetry, and also allows a high speed for the toothed gearing, which is fixed at 18 m. per sec. The large wheel has 147 teeth, the small one 69; the pitch is 6π mm., and the breadth of the tooth 100 mm. Tests were previously made with speeds of toothed-gearing up to 25 m. per sec.; and from these it appeared to be insufficient to run the gearing in a bath of oil or grease. An arrangement is therefore adopted by which the oil is injected on the wheels under a pressure of about 5 cm. of mercury from a small tank, which is filled under pressure by a pump. The oil must be injected on the teeth on that side on which they engage, and consequently arrangements are made for feeding in the oil from opposite sides on the forward and backward journeys. The motor bearings are 300 mm. long, and the spindle has a diameter of 100 m. The air-gap is said to be between 1·5 and 2 mm. The rotor has a diameter of 68 cm., and a breadth of 80 cm. The stator, which receives the high pressure, has 72 slots, and 67 conductors per slot, which are wound in mica tubes. The winding of the rotor consists of flat copper bars, contained in half-closed slots; the voltage developed in the rotor at starting is 700. The high-tension cables are brought to the motor through rubber bushes, which are themselves mounted in vulcanite bushes. The starting is effected by means of metallic resistances, and the switchboard arrangements are in general very similar to those on the high-speed car already described. The pneumatic pressure for the brake is supplied by a small pump, driven by a 110-volt motor, which receives its current through a small transformer. After being handed over, the locomotive was tested with gradually increasing voltages, starting with 6,000 volts at

[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines

Digitized by Google

25 cycles, and with speeds between 55 km. and 100 km. an hour. On the last test 11,000 volts were applied at 48 cycles, and a carriage weighing 81 tons was taken as a load, a speed of 105 km. per hour being reached. The author states that an electric train, worked on this principle, and taking 100 passengers, weighs 1,180 kg. per passenger, whereas a train worked by steam, would weigh 1,800 kg. per passenger. W. H. S.

316. *Electric Traction in Relation to Existing Railways.* **J. W. Jacomb-Hood.** (Electrician, 49. pp. 1037–1038, Oct. 17, 1902. Extract from paper read before L. & S. W. Rly. Debating Society.) — The author discusses the limitations of steam working on branch lines due to heavy trains and infrequent service; heavy station expenses; cost of signalling; and wear and tear due to reciprocating engines, and compares these with the advantages offered by electricity. He then outlined a system of electric traction for 70 miles of the L. & S. W. Rly. lines, giving the probable number of trains and passengers, the position and capacity of the generating stations. Basing his calculations on 40 trains, and 5,000,000 train miles per annum, and 75,000,000 passenger miles, against the present 1,500,000 train miles and 45,900,000 passenger miles, he shows the financial results that might accrue to the Company. This works out that each additional passenger must contribute only 0·43d. per mile in order to secure to the Company a return on the capital, and above that, $\frac{1}{15}$d. per mile per passenger is all that is necessary to pay 1 per cent. profit. F. B.

ELECTRIC LAMPS AND LIGHTING.

317. *Lighting of Matzleinsdorf Goods Station, Austria.* **C. Jordan.** (Zeitschr. Elektrotechn., Wien, 20. pp. 894–899, Aug. 10, 1902.)—The lighting of this station on the Southern Railway Company's line is carried out by arc lamps. Power is supplied by three-phase machines at 950 volts; and this pressure is transformed and distributed on the three-wire system with 220 volts between the outers. W. H. S.

REFERENCES.

318. *Overhead Wire Spans.* **K. Krohne.** (Elektrotechn. Zeitschr. 23. pp. 593–595, July 3, 1902.)—In this article the author points out that the ordinary formulæ for calculating stresses in designing overhead wire spans are insufficient to enable accurate results to be obtained, as they neglect to take into account the effect of wind pressure and the increased load to which the wire may be subjected by snow or ice accumulation. The effect of these factors is discussed, and new formulæ are developed, the results of calculations on which are plotted in the form of curves, showing the relationship between temperature, span, and dip for wires of different sections. J. G.

319. *Compounding Generators, and Niagara Falls Plant.* (Amer. Inst. Elect. Engin., Trans. 19. pp. 1139–1145, Aug.–Sept., 1902.)—This is a discussion on the papers dealt with in Abstracts Nos. 2167 and 2350 (1902). G. W. DE T.

320. *Speed-Time Curves.* **C. O. Mailloux.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1035–1135, Aug.–Sept., 1902.)—Methods are described of studying and analysing electric railway problems by means of curves. F. B.

Digitized by Google

TELEGRAPHY AND TELEPHONY.

321. *Muirhead's Cable Relay.* **J. Munro.** (Elect. Rev. 51. pp. 602–604, Oct. 3; 641–643, Oct. 10; and pp. 677–678, Oct. 17, 1902.)—To correct the shifting zero Muirhead's automatic sounding key or curb transmitter was adopted by the Eastern Telegraph Company in 1894, but a better remedy at the receiving station was found in 1898 in his inductance or self-induction shunt joined in parallel with the condenser and signal coil. This shunt is adjusted so that the first impulse from the cable gives a good signal before the current can flow through the shunt, and at cessation there is a quick return to zero. The vibrating siphon for facilitating discharge of the ink was patented by Muirhead in 1893, and in adapting the coil of the recorder for relaying purposes an improved suspension was devised. In 1899 Muirhead used these earlier inventions for his "jockey tongue" relay. The

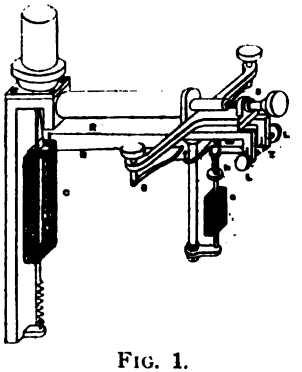


FIG. 1.

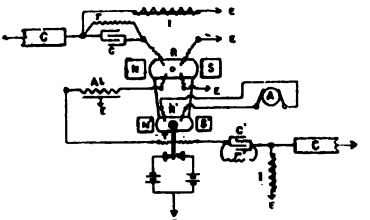


FIG. 2.

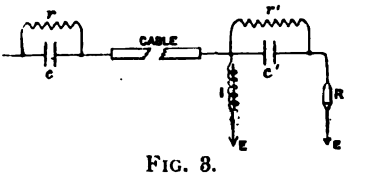


FIG. 3.

moving parts are shown in Fig. 1, and a plan of the connections in Fig. 2. In the latter is also shown the "overflow" circuit, or artificial cable, which serves both to bring the tongue back to zero, and to restore the "ripples" which have been smoothed out of the signals on a very long cable. In 1899 a "jockey tongue" relay, with an "overflow" circuit, was installed at Malta; *c* is the receiving condenser, R the signal coil of the relay between the poles, N S, of its magnets, and E the earth. An inductance shunt, I, is connected across the condenser and receiver to earth, and an ordinary resistance, or non-inductive shunt, *r*, across the condenser. The second coil of the relay, R′, between the magnets, N′ S′, is actuated from the signal coil, R, by the arrangement shown in Fig. 2, and is vibrated by the current from an alternator, A, flowing through it. The jockey tongue vibrates with it between the terminals of the local battery, and is connected to the following cable through a condenser *c*, shunted by a resistance *r′*, with an inductance coil 1 to earth. There is also an "overflow" circuit from the tongue through a section of artificial line, A L, and the signal coil to earth. This "overflow," combined with the inductive shunt, has the effect of curbing the coil, overcoming the variable zero, and giving a neat, "square" form to the signals. The "over-

Digitized by Google

flow" was subsequently discarded, and the arrangement in Fig. 8 adopted. In this diagram r is a low resistance and r' a high one, I is an inductance by-pass or shunt. Signals from St. Helena and Porthcurnow with relay at St. Vincent were found to be good. On adjusting inductance and resistance of shunt and receiving condenser and its shunt, the signals were effectively curbed and shaped at the receiving end without reference to the sending station. With such an arrangement the smoothed out signals are not split up into their original constituents, but, to do so, a mechanism can be caused to apply a shunt to the receiving coil of the relay at intervals corresponding to the duration of a short signal, thus introducing the serrations. In 1901 in place of the jockey tongue a taut bronze wire from the cradle of the siphon was vibrated by an electromagnet between the two terminal stops of a weak local battery, and making contact one side or the other as the recorder coil swings, actuates two post-office or other relays, which transmit from a stronger battery to the forward cable. The arrangement is shown in Fig. 4. Again, introducing the Varley principle of moving contacts, Muirhead intro-

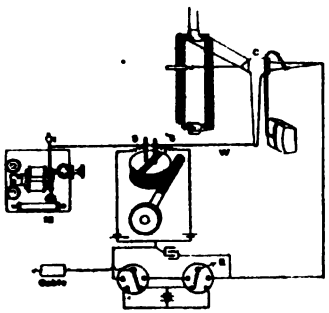


FIG. 4.

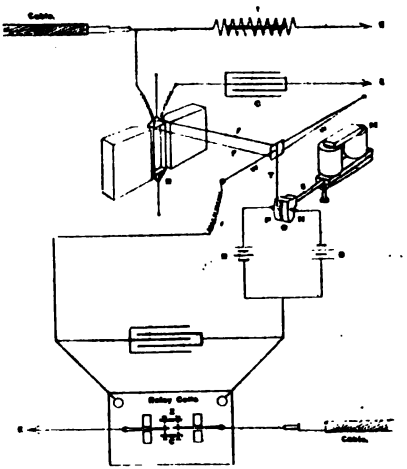


FIG. 5.

duced the form of relay shown in Fig. 5. Here PP are silver plates, slightly convex, mounted side by side on a flat spring, and vibrated up and down by the electromagnet shown. The plates are insulated from each other by mica and the tongue or "trailer" T, with a recurring point, rests normally on a centre ring of silver between the mica and the plates. The "trailer" moves from side to side when signals arrive, and can actuate sounders on relays for retransmission. The vibration of the plates appears to diminish friction and to ensure a good rubbing contact. Any siphon recorder can quickly be transformed into a relay, or *vice versâ*, by exchanging the siphon for a "trailer," and the frame carrying the paper and ink for that with the vibrating plates or the contrary. Ordinary earth currents are provided for by the self-induction shunt, but for exceptional disturbances a special device is added to the relay by which the cradle is controlled and zero maintained. Should it be requisite to split up the prolonged signals (or reproduce the lost "ripples"), Muirhead uses the arrangement shown in Fig. 6, where T_1, T_2, T_3 are electromagnets or sounders, U a retardation, W an "overflow" circuit, and S_1 S_2 the coils of a cable transmitter. The armature of T_2 breaks the

Digitized by Google

circuit at intervals, dependent upon the retardation in U when the "trailer" is to the left, and so forth, and the coils of the transmitter are thus affected, while the "overflow" device, with sounder T_3, produces the right shape of signals for working the relay. Another method patented in 1901 for effecting the same purpose by a perforated tape is shown in Fig. 7. The perforator is usually manipulated by the operator pressing down one or other of three keys, but in the present case the keys are pulled down by the electromagnets

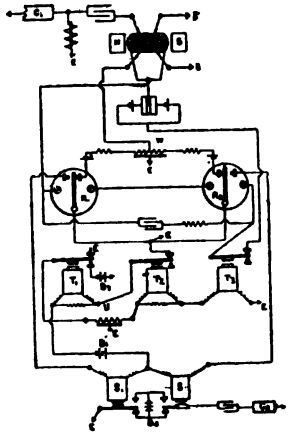


FIG. 6.

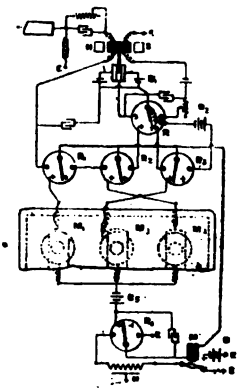


FIG. 7.

M_4, M_2, and M_3 actuating respectively the "dot," spacing, and "dash" punches. When the "trailer" is in its middle position there is a succession of spacing holes in the tape, the intervals depending on retardation at U; when the "trailer" is to the left electrogmagnet M_1 perforates a "dot" hole. Relay R_2 does not in this case respond as it is polarised. The circuit of M_1 is interrupted periodically by M and relay R_4 so long as the "trailer" is to the left, hence a series of "dot" holes. Similarly when to the right a "dash" or series of "dash" holes is punched. E. O. W.

322. *Telephonic Receiver for Wireless Telegraphy.* **L. Bleekrode.** (Nature, 66. p. 848, Aug. 7, 1902.)—The author, in some test experiments with the Popoff system, between the Hook of Holland and a lightship 16 km. away, successfully used as receiver a pair of parallel arc-lamp carbons fixed to a wooden base in circuit with a pair of small dry cells and an Ader telephone, the circuit being completed by several sewing needles resting transversely on the carbon rods. No tapping was required, although when the telephone was removed the arrangement was not self-decohering. The author suggests that the self-induction of the telephone may have been sufficient to cause the decoherence. When a load of as much as 5 kg. was placed on a glass plate resting on the needles there was no apparent diminution in sensibility, although a much smaller weight was sufficient to destroy the microphonic sensitiveness. G. W. DE T.

Digitized by Google

SCIENCE ABSTRACTS.

Section B.—ENGINEERING.

APRIL 1903.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

323. *Steam Turbine.* (Power, N.Y. 22. pp. 40–41, Oct., 1902.)—Description of the 1,250-kw. turbines which are to be built by the Westinghouse Company for lighting the New York rapid transit subway. Each turbine is divided into high- and low-pressure portions with bearings between, and the steam is led from the former to the latter through a large reheater. They are to run at 1,200 r.p.m., with a boiler pressure of 175 lbs. per sq. in. and a vacuum of 27 in. The guaranteed consumption is 15·5 lbs. per e.h.p.-hour at full load and 18·5 lbs. at half load, with dry steam; with 75° F. superheat the figures are 13·9 lbs. and 16·2 lbs. There is a by-pass admitting steam to the low-pressure portion, and when that is opened the turbine will carry an overload of 50 per cent. with the condenser, or full load without the condenser. H. R. C.

324. *Tests of a Hult Rotary Steam Engine.* (Engineering, 74. pp. 506–508, Oct. 17, 1902.)—The following figures are given of the performances of different sizes of these engines, with a steam pressure of 142 lbs. per sq. in. and exhaust at atmospheric pressure :—

B.H.P.	Steam per b.h.p.-hour.	Revs. per min.	Weight of Complete Engine.
8	—	1,500	1¼ cwt.
12	36 lbs.	1,300	4½ „
20	33 „	1,250	6 „
40	31 „	1,000	12 „
60	29·5 „	850	17½ „
80	28 „	700	23 „
120	27·5 „	550	38 „
200	27 „	500	52 „

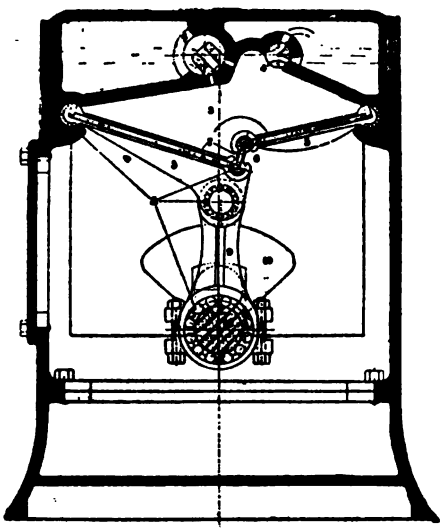
[See also Abstract No. 942 (1901).] H. R. C.

325. *Engine Breakdown through Fatigue of Materials.* (Mech. Eng. 10. p. 597, Nov. 1, 1902.)—The breakdown occurred with a pair of beam engines,

Digitized by Google

with cylinders 28 in. and 44 in. diameter by 6 ft. stroke, having cranks at right angles, and running at a speed of 84 r.p.m. The beam of the high-pressure engine broke while the engines were under absolutely normal load, such as the beam had worked under for many years, the cause being apparently deterioration by fatigue. Calculations give the stress as about 7,000 lbs. tension and compression, the range being thus 14,000 lbs. per sq. in. The owners had declined to reduce the steam pressure on the grounds that the beam had worked safely for a large number of years. H. R. C.

326. *Sleeper Steam Engine.* (Horseless Age, 10. p. 279, Sept. 10, 1902.)—This is a new form of steam engine recently introduced by the Sleeper Engine Co. of Montreal. It is stated to be suitable for automobile as well as other purposes, and that the 5-b.h.p. size weighs only 85 lbs. The mode of action of the engine will be seen from the diagram. The expansion chamber



has hinged walls, with a system of packing strips and springs at the edges to prevent leakage; the movement of the hinged walls actuates the connecting rod and crank; steam is admitted and exhausted by valves of the Corliss type. Roller bearings are used throughout. Tests on a 12-h.p. engine, conducted at the McGill University laboratory, give the following figures, the steam being condensed at atmospheric pressure :—

B.H.P.	Revs. per min.	Steam Pressure (Gauge).	Steam per b.p.h.-hour.
5·68	650	44	56·5 lbs.
10·2	707	58	40·4 „
18·1	726	84	36·4 „

H. R. C.

327. *Measurement of Variations in Angular Velocity and Angular Displacement.* **F. Klönne.** (Elektrótechn. Zeitschr. 28. pp. 715–720, Aug. 14;

Digitized by Google

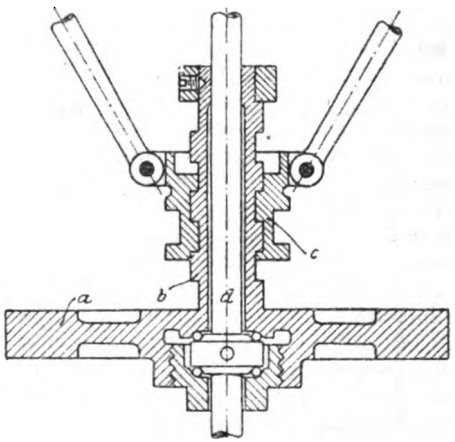
Discussion, pp. 758–759, Aug. 21, 1902. Report read before the 10 Jahresversammlung des Verbandes Deutscher Elektrotechniker at Düsseldorf.)—The method here described is for determining the angular displacement of the rotating mass from the position corresponding to its mean velocity. This is actually of more importance than the momentary variations of velocity, though these can be deduced from it. An ideal method would be to arrange a drum close to the flywheel in question and revolving uniformly at the mean velocity of the latter. In the present method a small independent drum is used having approximately the same peripheral velocity as the flywheel. On the surface of the latter a number of contacts are arranged, so as to make and break a circuit. This is conveniently effected by wrapping round it a steel tape in which a number of holes are punched which are afterwards filled in with shellac. The holes can be punched at equal pitch to an accuracy of 0·1 mm. The ends of the tape constitute an irregularity, but this helps to identify the position of the engine crank on the record. The circuit so made and broken includes an induction coil, the secondary of which sparks on to the rusty surface of the drum, producing a small mark for each interruption. The positions of these marks is read off by the help of a divided scale with vernier on the drum and a lens with cross wire. The drum is driven by a continuous-current motor from accumulators. It is not necessary that the peripheral speed should be equal to that of the flywheel, though that simplifies the readings, but it must be very uniform, and in the experiments hitherto made this has been found to be the chief source of error. But this can no doubt be largely overcome. Inequality in the pitch of the holes does not matter if the inequality is known, and similarly the error due to want of truth in the flywheel can be allowed for. Examples of readings taken by the method were given. **Franke,** while recognising the elegance of the method, questioned the possibility of attaining the accuracy claimed by the author, particularly owing to uncertainty as to the exact point of interruption at the edges of the holes in the steel tape and irregularity in the speed of the drum. **The Author,** replying, said that a similar steel tape on the drum itself gave 21 records, of which the maximum variation from the mean was less than 0·1 mm. The variations in the speed of the drum were not such as to prevent sufficient accuracy for many purposes, and he hoped to obtain better results in the light of his present experience. A. E. L.

328. *Governing of Steam Engines.* **B. Rülf.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1807–1814, Aug. 30; and pp. 1899–1403, Sept. 13, 1902.)—The papers of Wischnegradsky (Civilingingenieur, 1877, S. 95), Tolle (Z.V.D.I. 1895), Stodala (Z.V.D.I. 1899), and Isaachsen (Z.V.D.I. 1899),[1] deal only with the stability of governors. Pfarr (Z.V.D.I. 1899) investigated the problem of the periodic rise and fall in turbine governors, and the author considers the same problem in engine governors. The paper is purely theoretical, the aim being to arrive at a graphical solution. It remains to be proved whether the construction is applicable in practice. If an undamped governor is kept running at a constant speed and is forcibly disturbed from its stable position, its collar acquires a simple harmonic motion with a period of $T = 2\pi\sqrt{\frac{m}{c_1}}$, where m is the equivalent mass moved and c_1 the spring constant. In order to entirely damp the harmonic motion a damping resistance $b = 2\sqrt{mc_1}$ must be provided, where b is the resistance of the dashpot at unit velocity; the

[1] For similar papers by Wilson-Hartnell, see Inst.-Mech. Eng. Proc., 1882.

Digitized by Google

time-curve indicating the governor's motion then becomes asymtotic to the position of stability instead of being sinusoidal. For every instantaneous speed of the governor (and therefore of the engine), there is a corresponding stable position, g, of the collar, which position the latter is always tending to assume, and this action is conveniently considered by plotting the actual position r of the collar, and g as ordinates to a time abscissa. If the speed of the engine is constant and the governor is in a stable position, r and g follow the same horizontal path. If the engine speed varies the path of g becomes inclined (the tangent representing with close approximation the rate of change of speed), and r follows a path which, with a perfectly damped governor, lags behind



that of g, until the condition of stability is again reached, and it is on this principle that the author elaborates his theory. The effects of sluggishness, inertia of the balls or equivalent parts, the valve gear, and the cyclic variation of engine speed are considered. A method of increasing an ordinary ball-governor's rapidity of action is shown in the accompanying illustration. It will be seen that, should the engine speed fall, inertia will keep up the speed of the small flywheel *a* above that of the governor and make it rotate relatively to the collar *c*, which will consequently be screwed down and the ordinary motion of *c* hastened by this auxiliary screwing motion. A somewhat similar inertia effect is commonly made use of with shaft governors. R. C. R.

329. *Hand Adjustment of Engine Governors.* **J. H. Dales.** (Electrician, 49. pp. 953–954, Oct. 3, 1902.)—In this paper the author lays stress on the great improvement attained by using high governor speeds and ball bearings instead of plain pin joints, thus reducing both inertia and friction. A total variation in speed of 1½ to 2 per cent. is given as the possible limit which can be reached under these conditions; and of this total the author considers that about half would be absorbed in action due to inertia and friction, and the other half in changing the position of the governor. Such a governor therefore adjusted to 2 per cent. total could not be screwed up to *raise* the speed without causing racing. As regards the question of hand adjustment, it is shown that the best possible results to be attained from the best quality of governor, with a 10 per cent. hand adjustment, would, as an extreme reduction, be 11 per cent. variation of speed over the full range, and as a mean not less than 5½ per cent. Variations due to imperfections in the

Digitized by Google

governor might bring this up to 8 per cent. By simple mechanism, however, it is possible to make a governor which will admit of speed adjustment without spoiling the quality of the governing. B. P. S.

330. *Mechanical Draught for Boilers.* **W. L. Sutcliffe.** (Mech. Eng. 10. pp. 724–727, Nov. 29, 1902.)—This paper deals with the elements of the subject, and gives a statement in figures of the comparative efficiency of chimney and fan for draught production, the conclusion of which is that the fan efficiency (allowing for friction in its case) is $\frac{0{\cdot}04}{0{\cdot}000568}$ or 71·05 times greater than that of the chimney, and that, in practice, examples from 80 to 400 times more efficient are found. A simple arrangement for automatic control of induced or forced draught fans is described, the speed being regulated by the boiler pressure or the demand for steam. It consists of two branches from the main steam pipe commencing on the boiler side of the stop valve and led back to the pipe beyond it, so that steam may be taken at starting direct through the main stop valve and afterwards through the branches. One branch is just large enough in diameter to supply steam sufficient to keep the engine and fan running with maximum steam pressure, and in the other branch is inserted a reducing valve adjusted so that when the steam pressure in the boiler drops, more steam goes through the valve to the fan engine. The control is so good and the required draught is given so quickly that the boiler pressure does not vary more than a pound either way. [See also Abstracts Nos. 948 and 1180 (1902).] F. J. R.

331. *Balcke Condensing Plant at Düsseldorf.* (Electrical Times, 22. p. 714, Nov. 13, 1902.)—This plant condensed all the exhaust steam from the various steam engines in the Düsseldorf Exhibition, and thus dealt with about 80,000 lbs. steam per hour. A photograph accompanies the article, showing the pagoda-shaped wooden tower and the chimney-shaped iron tower with the pump-house in the background. The exhaust steam is first passed through an oil separator and then through a twin condenser consisting of two mild steel vessels fixed one above another. Each has two chambers for the steam and for the water, so that the steam is passed twice through each vessel from the bottom to the top whilst the condensing water passes in the opposite directions. Much importance is attached to the counter-current arrangement. The pumps are driven by tail-rods from a compound steam engine—one water pump being able to deliver about 264,000 galls. per hour, and one slide valve air-pump capable of dealing with 440,000 cub. ft. of air per hour. The wooden cooling tower can cool about 176,000 galls. per hour, the water being distributed in it by a system of troughs and being made to drop from the cooling stacks into the cooling tower tank in the opposite direction to the air draught. The iron tower is 115 ft. high, and from the draught thus produced has a high efficiency per cubic foot of base area. It distributes the water by sieve sheets lined with zinc. F. J. R.

332. *Arthur Automatic Stoker.* (Engineer, 94. p. 478, Nov. 14, 1902.)—Illustrations are given of this stoker, which is of the coking and "overfeed" variety, somewhat on the lines of the Vicars' design, but differing in having alternate bars movable and fixed. The movable bars when full out are first raised up slightly above the level of the fixed bars, then travelled inward for some distance, and then moved downwards till a little below the fixed bar level and brought back at the lower level. The movements are effected by cams and rollers. F. J. R.

Digitized by Google

333. *Oil Fuel for Generating Stations.* **E. Stanley.** (Electrical Times, 22. pp. 785–786, Nov. 27, 1902.)—This paper gives some facts relating to the use of the Morrissey burner as applied to firing the steam boilers at the General Electric Car Station of San Francisco. The storage tanks contain steam coils which maintain the temperature of the oil at about 175° F., and from these it is pumped through pipes reduced to 1¼ in. diameter at the boiler. The steam pipe which joins the oil pipe is also 1¼ in. diameter, and steam and oil meet before being passed through the burner, the mixture being of course regulated by taps on the pipes. The end of the Morrissey burner is about 1¾ in. diameter and the opening for the oil is "a circular slot which is $\frac{1}{50}$ in. diameter." The flame extends from this opening and with Texas oil averaged in length 12 to 14 ft. 15½ lbs. of steam to 1 lb. of oil was said to be the rate of evaporation, and 15,000 galls. of oil at 2 cents a gall. was the daily consumption as against a former one of 100 tons of coal at 6 dollars per ton; the average output per day being 68,000 kw. [See also Abstracts Nos. 950, 1766, 1944, 2810 (1902).] F. J. R.

334. *Oil Fuel in the U.S. Navy.* (Engineer, 94. p. 476, Nov. 14, and pp. 486–487, Nov. 21, 1902.)—The Annual Report of the Bureau of Steam Engineering to the Secretary of the U.S. Navy contains the report of the Oil Fuel Board appointed by Admiral Melville to acquire information regarding the possibility of substituting oil for coal as fuel in warships. The introduction by Lieutenant Ward Winchell deals with the more general aspect of the subject and its military significance. Regarding apparatus, he states that whilst there are many burners in existence which can deal satisfactorily with moderate quantities of oil, none can burn enough oil under forced draught, so that it is not yet practicable to get as much steam from a given boiler with oil as with coal. The general results arrived at by the Board are as follows:—(*a*) That oil can be burned in a very uniform manner. (*b*) That the evaporative efficiency of nearly every kind of oil per lb. of combustible is probably the same. (*c*) That a marine steam generator can be forced to even as high a degree with oil as with coal. (*d*) That up to the present no ill effects have been shown upon the boiler. (*e*) That the firemen are disposed to favour oil, and therefore no impediment will be met with in this respect. (*f*) That the air required for combustion should be heated before entering the furnace. (*g*) That the oil should be heated so that it should be atomised more readily. (*h*) That when using steam, higher pressures are undoubtedly more advantageous than lower pressures for atomising the oil. (*i*) That under heavy forced draught conditions, and particularly when steam is used, the Board has not yet found it possible to prevent smoke issuing from the stack, although special efforts were made to obtain complete combustion. This inability to prevent smoke will have an important influence upon the use of oil fuel not only for naval purposes but also for land installations which require to be forced. (*j*) That the consumption of liquid fuel cannot probably be forced to as great an extent with steam as with compressed air for the atomising agent—probably on account of oxygen being supplied by the latter and displaced by the former. In their tests the Board used a Hohenstein water-tube boiler, of which an illustration is given, and made trial of several burners, two of these having been designed by the Oil City Boiler Works, one being the Hayes hydrocarbon burner and a fourth the Reed combined steam and air burner. Illustrations of these burners are given; and a table of results of a three-hours' test with forced draught accompanies the paper. [See also preceding Abstract.] F. J. R.

Digitized by Google

335. *Water Softener of the Maschinen-Fabrik Grevenbroich.* (Engineering, 74. p. 670, Nov. 21, 1902.)—This is a precipitation tank and horizontal filter press combined, heater cells being also united in the same framing. The heater cells are placed on the right-hand side of the precipitation cylinder and the filter press on the left. The filtered water returns through the heater cells, so that the steam is fully utilised, as the feed water has to be heated in any case. The vertical compound pump, which also works the lye-pump, takes the water from the condensing water tank, forces it through the heater cells, which are arranged in series, and then into the precipitation cylinder, where it is mixed with the chemicals, and the turbid liquid is forced through the filter and conducted back through the precipitation cylinder and the heater cells to the pure water tank. The heater cells are built up of ribbed plates with separate passages for steam and water; the water ascends in a zigzag path to a common channel above and goes to the precipitation chamber. The steam descends in a similar manner in separate chambers or passages, and flows off below through a pipe. The filter plates have peculiar corrugations, but the filter construction is otherwise as usual. Details of heater cells and filter plates are shown in the illustrations which accompany this article. The sizes of heater plates are 600 by 700 mm. (23·6 by 27·6 in.) and 30 mm. (1·2 in.) thick. For the filter presses a thickness of 40 mm. (1·6 in.) is required. The maximum capacity of these apparatus is 2,200 galls. per hour. F. J. R.

GAS AND OIL ENGINES.

336. *Napier Ignition Commutator.* (France Automobile, 7. p. 651, Oct. 11, 1902.)—In this commutator for distributing current to the low-tension circuits of four induction coils, a cam on the extremity of the half-speed shaft of the engine makes contact consecutively with four brushes mounted on a vulcanite disc, which may be given an angular movement around the half-speed shaft for retarding or advancing the point of ignition. Behind the vulcanite disc there are also four brushes in connection with the cam contact brushes, and these make connection to four segments connected to four terminals on a second vulcanite disc. These terminals are coupled to four terminals on the coils, the other ends of the low-tension circuit of which are connected to the + battery terminal. The — battery terminal is earthed, as is also the cam on the half-speed shaft, which makes contact with the brushes of the commutator. C. R. D'E.

AUTOMOBILISM.[1]

337. *Salamandrine Boiler.* (Automotor Journ. 7. pp. 680–682, Oct. 25, 1902.)—This boiler, which is intended more especially for use on light steam motor vehicles, consists of a vertical cylindrical drum, surrounded by spiral coils of tubing, the ends of which are connected to the upper and lower extremities of the drum. The major portion of the heating surface of the boiler is supplied by these coils of tubing, which, together with the drum, form the water space of the boiler. Steam is taken off from a second drum connected to the upper portion of the water drum. Around the heating coils is placed a single large coil of tubing, which serves as a feed-water heater. The boiler is fired from below by a gasolene burner. Various sizes from 6 h.p., weight 180 lbs., to 25 h.p., weight 450 lbs., are constructed. It is said to be practically impossible to burn out this type of boiler. C. R. D'E.

[1] Electric Automobiles are described in the Section dealing with Electric Traction.

Digitized by Google

338. *Motor Manufacturing Company's Cars.* (Automotor Journ. 7. pp. 622–625, Oct. 11, 1902.)—Three types of petrol cars manufactured by this company are described, viz., 8-h.p. single cylinder, 10-h.p. double cylinder, and 20-h.p. four cylinder. In each case the engine is mounted towards the front of the underframe, and the power is transmitted from engine to change-speed gear through a cone friction clutch, thence by bevel gearing to the differential cross-shaft, and finally by chains to the rear road wheels. The engines in all cases have vertical water-cooled cylinders, and are fitted with electric ignition. C. R. D'E.

339. *Swift Voiturette.* (Automotor Journ. 7. pp. 645–648, Oct. 18, 1902.)—This is a light two-seated vehicle, propelled by a single-cylinder vertical engine, mounted towards the front of a steel tube underframe. The transmission gear consists simply of two sets of bevel gears mounted upon the live rear axle, and so arranged that either gear may be brought into action whilst the other runs free. The underframe of the vehicle is sprung on semi-elliptic springs from the front axle, and is directly connected to the bearings of the live axle, springs being here provided for the carriage body only. C. R. D'E.

340. *Milnes Voiturette.* (Automotor Journ. 7. pp. 672–675, Oct. 25, 1902.)—This is a light petrol car, propelled by a double-cylinder vertical engine, mounted towards the front of the underframe. The power is transmitted to the change-speed gear through a cone friction clutch, and thence by bevel gear to the differential cross-shaft, and by independent roller chains to the rear road wheels. In the change gear three forward speeds and one reverse are obtained by sliding spur-wheels. The engine is fitted with mechanically operated valves and low-tension electric ignition. Its cylinders are 90 mm. bore × 120 mm. stroke. C. R. D'E.

341. *Rochet Voiturette.* **L. Fournier.** (Locomotion Automobile, 9. pp. 628–632, Oct. 2, 1902.)—This is a light petrol voiturette, with seating accommodation for two or three persons, and having a total weight of only 260 kilos. It has a tubular underframe, and the engine and gearing are mounted near the back of the underframe behind the live rear axle. The engine is a water-cooled Astor, with single vertical cylinder. The power is transmitted through a cone clutch and epicyclic two-speed gear at the spur reduction gear, which drives the live axle through the intermediary of the differential. C. R. D'E.

342. *Hewetson Motor Bicycle.* (Locomotion Automobile, 9. p. 648, Oct. 9, 1902.)—In this machine the form of the diamond frame is altered so as to make the front portion of the bottom stay conform with the curve of the front mudguard, while the back portion is horizontal. A vertical tube is added between the top stay and the horizontal portion of the bottom stay. In front of this tube is mounted the engine and the magneto ignition apparatus, while between it and the seat-post is the carburettor and petrol tank. The transmission is by a flat belt. The motor is of 1¾ h.p., and it is mounted with the cylinder vertical. C. R. D'E.

343. *Darracq 12-h.p. Car.* **M. Chérié.** (France Automobile, 7. pp. 681–684, Oct. 25, 1902.)—This is a light petrol car, carrying a 12-h.p. double-cylinder vertical engine, enclosed in a bonnet at the front of the underframe.

Digitized by Google

The transmission gear comprises a cone friction clutch, a three forward and one reverse speed change gear, and a bevel reduction gear on the live rear axle. The underframe is constructed of wood lined with steel plates, the engine and gear-box being attached to a subsidiary frame of angle steel. The petrol and water tanks are mounted upon the dashboard, while the radiator fills the opening in front of the bonnet. The flexible tail-shaft between change-gear and bevels has Hook's joints at both ends, and there is also a radius rod for maintaining the distance between axle and gear box. The spindle bevel pinion of the final reduction gear has bearings at both ends.

C. R. D'E.

344. *Rousseau Car.* (France Automobile, 7. pp. 652–653, Oct. 11, 1902.)—In this car it is proposed to transmit motion to the vehicle by means of a fifth wheel mounted between the ordinary rear wheels and in front of the back axle. The arrangement of the driving wheel permits of its being raised from the ground for running free. C. R. D'E.

345. *Power of Automobile Launches.* **F. Forest.** (Locomotion Automobile, 9. pp. 699–701, Oct. 30, 1902. Paper presented to the Congrès des Sociétés Nautiques, 1902.)—The author objects to mere races, because they yield no scientific information. He proposes that a turns counter should be adapted to each motor. For explosion engines, a standard value X of air and a standard value of X′ of petrol per h.p. might be adopted, or, to simplify matters, a Mathot indicator might be mounted on the cylinder. In this case the formula for h.p. is $F = 1/75(\pi D^2/4 \times CNP/120)$, $G = S \times C \times P \times N/9000$, for 1 cylinder, in which F is the h.p. = (75 kg. m.), S the area of the piston in sq. cm.; C the stroke in cm., P the mean pressure in kg. per sq. cm., N the number of r.p.m. For the electric motor, the energy delivered is the mean product, volts × mean amperes × time in hours = watt-hours. If, on such lines as these, the power of the motors can be determined, the following formula might be used. The h.p. F required to give to a launch of section B^2 at the water-line a speed in knots (1,852 m.) per hour : $F = V^3B^2/M^3$; whence $V = \frac{M^3\sqrt{F}}{B^2}$ and $M = VB^2/8\sqrt{F}$, can be drawn. It will be seen that V^3 is obtained from the timing, F the h.p. obtained as above, and B^2, though not commonly known by the owners of launches, is obtainable by measurements (by the author's sectiograph and sectiometer). The turns counter gives N turns of the screw, and Z the distance covered, so that Z/N is the real amount of advance per turn of the screw. With these data it is possible to discriminate between the factors which make up the merits of the competing boats, and separate marks might be given thus: 10 for speed, 10 for best motor efficiency, 10 for best screw efficiency, 10 for best total combined efficiency. The author advocates a complete revision of the rules of competition on such lines as the above. M. O'G.

REFERENCE.

346. *Sthénos Carburetter.* **J. Caël.** (Locomotion Automobile, 9. pp. 696–697, Oct. 30, 1902.)—This is a float-feed, spray carburetter in which special attention has been devoted to securing the best form for the orifices for the air admission, and to the form of the chamber around the petrol-jet. C. R. D'E.

Digitized by Google

INDUSTRIAL ELECTRO-CHEMISTRY AND GENERAL ELECTRICAL ENGINEERING.

347. *Electro-metallurgical Problems.* **A. A. Beadle.** (Elect. Rev. 51. pp. 586–588, Sept. 26; p. 608, Oct. 10; pp. 687–688, Oct. 24; and pp. 811–812, Nov. 14, 1902.)—In this series of articles the author discusses the present position of the electro-metallurgical methods as applied to the extraction and refining of the following metals :—Copper, lead, zinc, gold, and silver.

The minerals in which these metals usually occur, and the ordinary metallurgical methods of extraction are first described, and the "problem" presented to the electro-metallurgist for solution is then discussed at some length. Brief descriptions of the various patented processes for dealing with the above metals by electro-metallurgical methods are then given; and the author's opinions as to the most hopeful and promising lines of research and experiment are indicated.

Copper.—The Body, Siemens & Halske, Hœpfner & Marchese extraction processes are referred to. The author suggests the nitrate as a substitute for the sulphate salt for refining purposes. [See Abstract No. 2433 (1901).] *Lead.*—The Lyte, Keith, Borchers, and Tommasi processes are described. The author considers the methods depending upon the electrolysis of fused lead salts the most hopeful. *Zinc.*—The methods of Steinhart, Lyte, Ashcroft, Brewer, Troynam, Larsen, Ganelin, and Swinburne are described. The author is of opinion that future development will occur along the line of Swinburne's last patent, namely, electrolysis of fused zinc chloride. *Gold.*—The Siemens & Halske and Cowper-Coles electro-depositing processes from cyanide solutions are described, and the futility of attempting to extract gold from sea-water is commented on. *Silver.*—The Moebius and Borcher processes are dealt with. The author points out that the possibility of extracting silver from its ores by electrolysis of the fused chloride is remote, owing to the fact that the metal is always present in a very finely disseminated state in the gangue. J. B. C. K.

348. *The Betts Process for Refining Lead Bullion.* **T. Ulke.** (Eng. and Mining Journ. 74. pp. 475–476, Oct. 11, 1902.)—The Betts process for refining base lead bullion has been in use at Trail, near Seattle, British Columbia, for ten months, and the results have been so satisfactory that a plant with three times the capacity of the existing installation is to be erected. The plant at present installed treats 10 tons base lead bullion daily, and consists of 20 lead-lined wood depositing vats, similar in size and arrangement to the vats used in copper refining by the electrolytic method. The Betts process is based on the solubility of lead in an acid solution of lead fluo-silicate. This electrolyte is made by diluting the hydrofluoric acid of commerce with its own volume of water, and by then dissolving crushed quartz in the solution. When used with lead electrodes, after saturating with lead, such a solution of lead fluo-silicate yields lead at the kathodes with an e.m.f. of only 0·20 volt. The anodes and kathodes are arranged in the vats in parallel, while the vats are connected in series, a space of 1½ to 2 in. separates the electrodes. The current density used is about 14 amperes per sq. ft., and 260,000 ampere-hours or 87 e.h.p.-hours suffice to deposit 1,000 kg.

Digitized by Google

lead. With coal at $6 per ton, the cost of fuel required for operating the Betts process, inclusive of that required for melting and casting the anodes, would not exceed 60 cents per ton of refined lead. The slimes contain all the gold and silver originally present in the lead, and these slimes are at present being worked up for the noble metals at Seattle. They average 8,000 oz. gold and silver per ton. Ulke regards the process as a distinct advance in the metallurgy of lead. J. B. C. K.

349. *Submarine Cable Testing.* **T. Wolcott.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1375–1385; Discussion, pp. 1424–1432, Oct., 1902.)—The factory cable testing consists of (i) a preliminary breakdown test, (ii) electrostatic capacity, (iii) insulation resistance, (iv) conductor resistance, (v) armour wire (mechanical tests), (vi) galvanising test. Sometimes the core is on reels, but the preferable way is to lay it loosely in the tank, so that there is room for the water to percolate, and ensure that the core shall be of the same temperature as the water. (1) After 24 hours' immersion the breakdown test is applied. For the standard-sized core 7/21-in. B & S gauge (insulated with 1/64 in. of para, followed by 40 per cent. compound to an outside diameter of 9/32 in.), 5,000 volts alternating is used for five minutes. The perforation at the worst is not much larger than a pin-hole, and sometimes is not discovered till the galvanometer test is applied. (2) The standard core has 0·4 microfarad per statute mile as the maximum. A potent influence in changing the capacity is the high-voltage test. The high voltage increases the capacity for some time after its application. In two kinds of rubber-covered cable where observations of temperature variation of insulation resistance were made, the formulæ were found to be, for Fahrenheit degrees, (*a*) $\log (R_t/R_{60}) = (0{\cdot}00802488 + 0{\cdot}00044619t)(60 - t)$, and (*b*) $\log (R_t/R_{60}) = (0{\cdot}00845964 + 0{\cdot}000286604t)(60 - t)$. It was long ago discovered by Hockin that gutta-percha does not attain its proper resistance until several hours after it has attained a given temperature. Forty per cent. compound is made of 40 per cent. of pure para gum. When the bulk of the remaining 60 per cent. is made up of rubber substitutes, very little ash is left when burned, and the temperature coefficient is approximately 2 for a difference of temperature of 12° F. It is more accurately given by equation (*b*). The capacity of this compound does not increase so much by the high-voltage test as other compounds. The best Para is called up-river Para, one year old before it is manufactured. No African rubber or reclaimed rubber of any kind should be allowed. This rubber has a smoky smell, but no offensive or putrid odour. African rubber has an offensive, putrid odour, but no smoky smell. The mechanical tests are—tensile strength, elongation, twists in a given length, bending tests, &c. The U.S. Army Signal Corps has adopted 100,000 pounds per sq. in. for the ultimate tensile strength of armour wire. No. 10 B & S G wire gives tensile strength 814 pounds, elongation in a 10-in. sample 10 per cent.; in 6-in. 15 twists. To test for galvanising samples are immersed in a saturated solution of sulphate of copper for one minute, they are then removed and wiped dry. This operation is performed four times, after which the wire should show no signs of a copper deposit. Indication of the galvanising is given during the twist test, because poor galvanising peels off. M. O'G.

350. *Alternating-current Meter.* **G. Stern.** (Elektrotechn. Zeitschr. 23. pp. 774–779, Aug. 28, 1902.)—The Union Electricitäts-Gesellschaft have hitherto built the Thomson type of meter, but a new departure has been

Digitized by Google

made with an instrument which embodies the Ferraris principle, and which is not unlike the Chamberlain-Hookham pattern. Two parallel aluminium discs rotate on a vertical spindle, which runs in a jewelled bearing. Between these discs lie three electromagnet coils, the two outer ones being excited by the main current, while the centre one is connected to a shunt circuit. The outer poles adjacent to the aluminium discs are of opposite polarity, while the centre magnetic field is closed through a cast-iron yoke. The torque of the disc-armature will be proportional to the number of lines of force in the main and shunt coils, and will also depend on the angle of phase between the two fields. A full mathematical treatment of the theory of the instrument is given, together with the method of calibration. Characteristic curves are given. The smaller size of meter registers up to 50 amperes on a two-wire system, and to 25 amperes on a three-wire system. The temperature coefficient (15°–40° C.) is 0·001. The main-current losses amount to 1·81 watts at 110 volts; the shunt-circuit losses are 0·90 watt; total, 2·21 watts. E. S. R.

351. *Voigt and Haeffner's Electromagnetic Cut-outs and Switches.* **M. Vogelsang.** (Elektrotechn. Zeitschr. 23. pp. 847–850, Sept. 18, 1902. Paper read before the 10 Jahresversammlung des Verbandes Deutsche Elektrotechniker in Düsseldorf, 1902.)—In one form of this cut-out, designed for street-railway switchboards, the main switch-arm is pivotally mounted at one end, the current being apparently brought to the pivoted end through flexible metal strips. This arm is acted upon by a spring tending to hold it off the fixed brush contact-piece. To this arm is pivoted a second arm which bears a sparking piece at its free end and has a projection for coacting with a spring pawl pivoted to the independently mounted handle. The pivoted armature of the controlling electromagnet lifts this pawl when the current exceeds a predetermined value. A blow-out magnet with horned pole-pieces is also provided. In the form for use on street-railway cars, there is a bridge-piece turning about a central tubular axis, and apparently acted upon by a break-circuit spring. Through this axis extends the operating rod, which bears a cam-shaped arm acting at one side on a pin on a plate connected through the releasing pawl to the bridge-piece, and acted upon by a spring tending to open the switch. This plate has a projection coacting with a stationary spring pawl, which is tripped by the above-mentioned cam-shaped arm when the operating rod is turned backwards. The releasing pawl on the switch-arm has an arm extending to the axis of the switch, over which is arranged a pin on the armature of the controlling electromagnet. A high-tension cut-out is also illustrated, in which a maximum and minimum relay closes a shunt circuit, including the coils of the releasing magnet. An electromagnetically actuated switch is next described, in which the main switch bridge-piece is mounted on a spindle raised by a solenoidal electro-magnet and held in its raised position by a double gravity pawl, the movement of this pawl in order to engage with the above-mentioned spindle causing a rod to be released and to fall on to and depress a spring contact-arm so as to break the circuit of the main switch magnet. To open the main switch, the said rod is raised by a second electromagnet and trips the double pawl so as to release the spindle of the main switch. The double pawl then re-engages with the said rod, thus returning the switch to its original position, the circuit of the second electromagnet being broken by the opening of the main switch. A motor-starting rheostat is described, in which four of these switches are arranged to close one after the other, as the armature potential difference rises, and successively short-circuit the resistances of the rheostat. C. K. F.

Digitized by Google

352. *Automatic Transformer Switches.* **J. Schmidt.** (Elektrotechn. Zeitschr. 28. pp. 513–515, June 12, and pp. 539–543, June 19, 1902.)—A description of various types of automatic switches for removing transformers from circuit at times of light or no load. In the case of isolated transformers it is sufficient to switch out on the primary side only, but in the case of groups or of transformers feeding into a network both sides must be switched out. This may be done either by means of a relay switching in and out according to the current or by means of a clock. The Nuremberg municipal lighting department is making experiments with these switches. A. E. L.

353. *Lighting Miners' Safety Lamps by Electricity.* **E. Brown.** (Elect. Rev. 51. p. 840, Nov. 14, 1902. Paper read before the Institution of Mining Engineers.)—The device is intended to be used for the lighting of safety lamps in a more expeditious manner and without necessitating any considerable structural alteration in existing lamps. For this purpose a short metallic conductor is fixed in the glass surrounding the wick tube of the lamp. It projects inwards towards the wick tube and terminates just above it, its outer end being shaped so as to form a suitable contact-piece. By means of an induction coil and a special stand a spark is passed between the inner tip of the metallic conductor and the wick tube, thus lighting the lamp. Details are fully described, and a drawing is given. W. H. S.

354. *Electricity in the Signal Corps.* **S. Reber.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1397–1414; Discussion, pp. 1424–1432, Oct., 1902.)—This paper deals with the applications of electricity for signalling purposes in the U.S. army service. The work of the signal corps consists of the construction, repair, and operation of military telegraph lines, and the collection and transmission of information for the army by telegraph or otherwise. For efficient service in time of war a complete chain of communication must extend in an unbroken line from the extreme outposts in contact with the enemy back to the capital at Washington. This chain is divided into three parts, viz., permanent, semi-permanent and temporary, or flying lines. The first are usually those of the existing commercial telegraph and cable companies, ordinarily situated outside of the zone of active operations, and are operated under the methods of commercial practice. Semi-permanent lines are used to connect the principal base or depôt of supplies on the edge of the zone of operations with the field base within it, and are usually constructed by suspending the wires in the usual manner on the cross-arms of iron telegraph poles. The field, or flying, telegraph lines are used to connect the field base with general headquarters, and the general headquarters with all the principal subdivisions of the army even to the extreme outposts. For working the permanent and semi-permanent lines the ordinary Morse telegraph instruments are employed, but in the case of the flying lines, where the line is of necessity in some parts laid on damp ground and therefore earthed, the Morse telegraph is inapplicable, and the telephone is employed for signalling in conjunction with a buzzer. This latter apparatus consists simply of a coil of low resistance and high self-induction in series with a circuit-breaker, a telegraph key, and battery. Upon opening the circuit the discharge of the coil goes to line, and, owing to the high self-induction and consequently comparatively high e.m.f., enough current reaches the telephone receiver at the other end of the line to give audible signals. The telephones used in fortress service are modifications

Digitized by Google

of the standard commercial types, but for field work, where portability, simplicity, and mechanical strength are essential features, special telegraphic and telephonic apparatus have been devised by the U.S. army officers. The paper contains a fully illustrated description of these instruments, and also of the waggons employed for laying the field lines and the searchlight waggons for signalling service at night-time. The author concludes the paper by a description of the system of communication employed for fire-control in fortress service and points out that this system is at present in an unsatisfactory state chiefly on account of the difficulty of obtaining apparatus which will withstand the shocks of the guns in the firing stations. J. G.

355. *Economy of Electric Power in Quartz Mining.* **C. O. Poole.** (Journal of Electricity, S.F. 12. pp. 126–134, July, 1902. Paper presented to the Sixth Annual Convention of the Pacific Coast Electric Transmission Assoc., June 17, 18, 1902.)—This paper deals with the commercial advantage of using electrically transmitted power instead of locally generated power, more especially in the Amador and Calaveras districts, California. The fuels available are wood, coal, and oil. With these the writer calculates the h.p. per month at respectively $9·07, $15·84, $11·90. In this district electric power costs $6·50, so the saving is considerable. The mine managers favour electric power for all purposes except hoisting. The writer considers the best method of using electric power for hoisting is to use a compressor driven by a motor and have a receiver of considerable capacity, and then to hoist with a compressed-air engine, using some fuel preferably to reheat the air. Examples are given of this method of hoisting, and a good many figures of cost on some of the mines in the district. The article is illustrated. LL. B. A.

REFERENCES.

356. *Fire-Alarm System.* (Elektr. Tidsskr., Christiana, 15. No. 29. pp. 180–181, Oct. 17, 1902.)—In this paper a fire-alarm system, installed by the *Elektrisk Bureau* Company, is described. The scheme is very simple, as only two relays are used, and the Morse apparatus established in the streets are most convenient, as false signals, such as might occur by a wire falling down to the earth or coming into contact with other wires, are avoided. A further advantage is the possibility of establishing a whole series of signalling stations on the same line. A. G.

357. *Electricity in the U.S. Navy.* **W. M. McFarland.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1387–1395; Discussion, pp. 1424–1432, Oct., 1902.)—The author points out that the standard voltage for the Navy was fixed at 80 on account of the searchlights, and that great inconveniences resulted from the adoption of this unusual standard. Also the temperature rise allowed was unnecessarily low. The use of alternating currents and induction motors both on board ship and in the naval yards is advocated. A. H. A.

358. *Hydraulic Relays and Governors.* **A. Rigg.** (Engineer, 94. pp. 364–366, Oct. 17, 1902.)—This is a description of a hydraulic relay, and an examination of the conditions for good working and absence of hunting. H. R. C.

Digitized by Google

GENERATORS, MOTORS, AND TRANSFORMERS.

359. *Standardisation of Electrical Machinery.* (Elektrotechn. Zeitschr. 23. pp. 764–767, Aug. 21, 1902.)—The paper contains the official rules and recommendations drawn up by the Verband Deutscher Elektrotechniker, and adopted by them for another year. The methods to be used in ascertaining the rise of temperature have already been noticed in Abstract No. 68 (1903). The general adoption of standard frequencies of 25 and 50 is urged in connection with all new alternate-current plants, and the following gradation in the number of poles is recommended: From 2–12 poles, steps of 2 poles; from 12 to 40 poles, steps of 4 poles; and beyond 40 poles, steps of 8 poles. The standard continuous-current voltages recommended are: For generators, 115, 230, 470, and 550 volts; for motors, 110, 220, 440, and 500. The alternate-current voltages are: For generators or the secondaries of transformers, 115, 230, 525, 1,050, 2,100, 3,150, and 5,250 volts; for motors or the primaries of transformers, 110, 220, 500, 1,000, 2,000, 3,000 and 5,000 volts. [See also Abstracts Nos. 2317 (1900), 2006 and 2018 (1901), and 1232 (1902).] A. H.

360. *Standardisation of Specifications Relating to Generators and Transformers.* **G. Dettmar.** (Elektrotechn. Zeitschr. 23. pp. 489–491, June 5, 1902.)—The author refers to some recent changes in the regulations issued by the Verband Deutscher Elektrotechniker [see Abstracts Nos. 2006 and 2018 (1901)]. Among these the following are the most important: An extension of the resistance method of determining the temperature rise has been decided upon, in accordance with the following table :—

Description of Machine.	Field Coils.	Primary.	Secondary.
Continuous Current Generators and Converters	Increase of resistance.	Thermometer.	—
Alternators and Synchronous Motors with stationary armature	Increase of resistance.	Increase of resistance.	—
Alternators and Synchronous Motors with revolving armature	Increase of resistance.	Thermometer.	—
Asynchronous Motors with stationary primary	—	Increase of resistance.	Thermometer.
Asynchronous Motors with rotating primary	—	Thermometer.	Increase of resistance.
Transformers.....	—	Thermometer.	Thermometer.

The values of the maximum permissible temperature rise are adhered to, with the exception of commutators, for which the new value of 60° is to be used in place of 80°. The voltage drop of an alternator is to be determined by the difference between the open-circuit e.m.f. and the p.d. on a load of power-factor 0·8, the exciting current and speed remaining constant. A. H.

Digitized by Google

361. *Determination of Dynamo Efficiency.* **J. R. Ashworth.** (Elect. Rev. 51. pp. 887–889, Nov. 28, 1902.)—The author gives an account of the method originally suggested by himself for finding the efficiency of a dynamo from the moment of inertia of the armature, and its rate of slowing down when the supply of power is cut off. A numerical example is given in illustration of the method, and the results obtained appear to indicate that the expression for the power lost on open circuit at different speeds involves a term which is proportional to the cube of the speed. [See Abstracts Nos. 199 (1898), 1431 (1899), 2493 (1900), 1795 (1901), and 1238 (1902).] A. H.

362. *Variable Speed Three-phase Motors.* **H. Behn-Eschenburg.** (Electrician, 50. pp. 178–181, Nov. 21, 1902.)—The Oerlikon Company has, since 1893, built three-phase induction motors, the speed of which can be varied by varying the number of poles. This can be done by varying the grouping of the windings or by employing two entirely distinct windings in the same grooves. The latter method requires specially large grooves, but the switching-over is simpler than with the former method. By combining both methods a four-speed motor can be built. The following results were obtained :—

No. of poles.	12	8	6	4	6	4
Connexion	Star	Star	Star	Star	Star	Star
Voltage	190	190	190	190	190	190
R.p.m. light	500	750	1000	1500	1000	1500
Load in h.p.	3·5	4	7	8	3·5	4
Torque in kg.m.	5·5	4·1	5·2	4	2·75	2
Efficiency, full load	72 %	78 %	85 %	86 %	80 %	80 %
Efficiency, half load	70 %	72 %	82 %	86 %	82 %	75 %
Power-factor full load	0·7	0·82	0·85	0·92	0·89	0·92
Power-factor half load	0·5	0·65	0·7	0·88	0·8	0·88
Slip at full load	10 %	7 %	3 %	4 %	3 %	6 %
Maximum torque kg.m.	9·5	6·2	18	12	5·8	4
No-load current	11	9	8·5	6	2·8	2
Starting current	50	50	130	135	43	45
Starting torque kg.m.	5·5	3·5	6	5	1·5	1·5
Heating after 3 hours full load	50° C.	50° C.	40° C.	40° C.	35° C.	35° C.

A. E. L.

363. *Losses in a Large Induction Motor.* **F. Bodensteiner.** (Elektrotechn. Zeitschr. 23. pp. 745–746, Aug. 21, 1902.)—The results are given of a series of tests on a 170-h.p. three-phase motor for 60 r.p.m. at 20·8 periods. The rotor had a diameter of 3120 mm., with a width of 200 mm. and 1·4 mm. air-gap. The no-load losses were determined by the method of G. Benischke [see Abstract No. 2277 (1901)]. The bearing friction is found to vary but little with the voltage. The losses in the rotor iron when standing still were higher than the frictional losses while running, so that the motor continued to run with open rotor circuit. Curves giving full details of the performance of the motor accompany the article. A. E. L.

REFERENCE.

364. *Transformers for Electrochemical Work.* **J. S. Peck.** (Electrochem. Ind., Philadelphia, 1. pp. 5–8, Sept., 1902.)—The requirements which these transformers have to fulfil are stated, and an interesting account is given of several methods of regulating the voltage. A. R.

Digitized by Google

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

365. *Calculation of a* 50,000-*H.P.,* 80,000-*Volt,* 200-*Mile Transmission Line.* **C. W. Hutton** and **R. Crowell.** (Journal of Electricity, S.F. 12. pp. 134 and 138–140, July, 1902. A paper presented to the Sixth Annual Convention of the Pacific Coast Electric Transmission Association, June 17–18, 1902.)—Since the inception of long-distance transmission plants, the introduction of oil as a fuel, whereby a saving of approximately 40 per cent. over the conditions of a few years ago is possible, has made the design of such transmission plants a matter of the highest importance, if they are to be a commercial as well as an engineering success. A rough-and-ready rule, due to C. F. Scott, for determining the pressure required to meet economic considerations, is that the pressure in thousands of volts will be equal to one-third of the number of miles it is required to transmit. On this basis a 200-mile transmission would require something under 70,000 volts; but using latticed steel towers in place of wooden poles for the line supports (the best construction, from the point of view of stability and lasting qualities) the cost would be considerably increased, and to counteract this 80,000 volts would be adopted as the pressure at the receiver end. On this basis the authors consider four cases: (*a*) two three-wire three-phase circuits, 60 ∿; (*b*) the same, 80 ∿; (*c*) four three-wire three-phase circuits, 60 ∿; (*d*) the same, 80 ∿. The conductors are to be of aluminium, the wires to be arranged at the corners of equilateral triangles and spaced 12 ft. between centres, power-factor of the delivered load 85 per cent., loss in transmission 15 per cent. From these data the sizes of the cables to give the required loss are worked out; two circuits of half a million circular mils. in area are required, the diameter being 0·82 in. The self-induction, capacity, charging current, resistance, and components of the load current are then calculated, and the regulation of the circuits deduced for the two periodicities, the results being also shown diagramatically; at 60 ∿ the regulation is 34·2 per cent., at 80 ∿ 23·2 per cent. The same calculations are gone through for four circuits, each of half the area of the preceding, the results being 18·2 per cent. regulation at 60 ∿ and 16 per cent. at 80 ∿. Further subdivision of circuits would effect only a slight improvement on these figures, while it would nearly double the volt-amperes for every twofold increase in the number of circuits. The authors recommend a periodicity of 80 ∿ or even less (with motor generator sets when lighting is required), as double the number of circuits can be used and better regulation thereby secured, with approximately the same result as regards the kilovolt amperes necessary to change the empty lines as if the power were transmitted at 60 ∿. B. P. S.

366. *Polycyclic System of Distribution.* **E. Arnold.** (Elektrotechn. Zeitschr. 23. pp. 569–571, June 26, and pp. 584–588, July 3, 1902. From a Report read before the Elektrotechn. Verein at Frankfurt, May 7, 1902.)—In the case of every combined lighting and power plant, the choice of a suitable frequency when alternating currents are used presents a good deal of difficulty, a high frequency being best for lighting purposes, and a low frequency

Digitized by Google

for motors. The author describes in detail the "polycyclic" method of working, devised and patented by himself, Bragstad, and la Cour, by means of which the same network may be used for two alternating currents of different frequency. It is easy to show that if two alternating currents of different frequency flow in the same circuit, then the power and heating effect corresponding to one of them are not in any way affected by the presence of the other. Taking the case of a star-connected three-phase system, it is evident that a single-phase generator could be introduced between the neutral points of the generator and motor (or transformer), and a single-phase current superposed on the three-phase currents, as shown in Fig. 1. A similar arrangement, shown in Fig. 2, might be adopted in the case

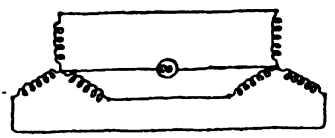


FIG. 1.

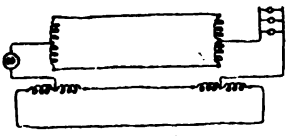


FIG. 2.

of a two-phase system, the middle points of the windings being utilised for the superposition of the current of higher frequency. Such arrangements had been previously proposed by F. Bedell, but the practical difficulty in the way of their adoption has been the powerful throttling effect which the superposed current would encounter in the windings of the polyphase generators and transformers. This difficulty has been ingeniously surmounted by the inventors of the polycyclic system, who wind the polyphase generators and transformers with a double winding, the two sections of which are so arranged that with respect to the superposed current the winding is non-inductive. Fig. 8 shows the method as applied to a three-phase system. In order to render the independent transformation of the two systems of currents possible, the inventors use a four-core transformer, three of whose cores serve

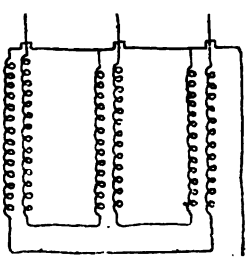


FIG. 8.

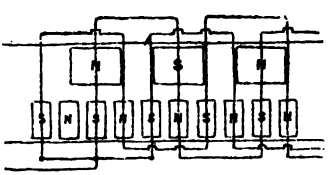


FIG. 4.

for the three-phase transformation, while the remaining one—through which the three-phase currents produce no flux—is used for the high-frequency single-phase current. A single generator may be employed for producing the low-frequency three-phase and the superposed high-frequency single-phase current. The general arrangement of the winding of such a generator is shown by Fig. 4; the armature conductors are subject to the inductive action of a double set of field poles, one set containing thrice the number of poles of the other. It is known that in a star-connected three-phaser the e.m.f.-wave can contain no third harmonics, since at any given instant these harmonics all act either towards the neutral point or away from it. Thus the three-phase network is not affected by the presence of third harmonics in the

Digitized by Google

windings. The author gives diagrams showing the applications of the system in various cases, and discusses the pressure-relations and pressure-drop. It is shown that a much larger drop is permissible than with ordinary systems, and that a large saving of copper may be effected. A. H.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

367. *Electric Light and Power in Korea.* **R. A. McLellan.** (Cassier, 22. pp. 596–601, Sept., 1902.)—Two 120-kw. double-current generators supply direct current at 550 volts to the tramways, and two-phase alternating current at 385 volts, transformed up to 2,000 volts, to several transformer stations, at which it is transformed down to 100 volts for lighting purposes. There are at present about 11 miles of tramway, with passenger and freight cars, and it is intended to construct another 12 miles. G. W. DE T.

368. *River Station of the United Electric Light Company of New Jersey, U.S.A.* (American Electrician, 14. pp. 455–463, Oct., 1902.)—This consists of a detailed description, with illustrations, of the generating and distributing plant in the rebuilt and enlarged station of this company at Newark. The system employed is two-phase alternating at a potential of 2,300 volts and a frequency of 60 cycles, step-up transformers converting to 6,000 volts being used for feeding the substations situated at the towns of Elizabeth and Orange. The arc lighting is by continuous currents generated by induction motor-driven machines at a pressure of 6,250 volts, and the current for incandescent lighting and power purposes is supplied from two-phase rotary converters transforming from 2,200 volts alternating to 220 volts continuous for three-wire lighting service and 550 volts for power. A noteworthy feature in the generating plant is the smallness of the piping used for the distribution of steam to the various engines. The plant has a capacity of 9,000 h.p., and, according to usual practice, the main steam pipes for this power would be from 24 to 30 in. in diameter; but in this case the largest main is only 14 in., and the engines are fed by a 12-in. main. In order to prevent excessive drop in pressure and to ensure delivery of sufficient steam a receiver of from three to five times the size of the high-pressure cylinder is placed near the throttle of each engine. In operation the maximum drop of pressure has never exceeded 8½ lbs. Another peculiarity in the steam distribution is the method of providing for expansion of the piping. Instead of expansion bends, a sort of swinging joint somewhat similar to that of a two-armed gas bracket is employed. The joint is extremely flexible, and it has been found to operate quite satisfactorily, no trouble having been experienced in keeping it steam-tight. J. G.

369. *Midland Electric Power Distribution.* (Electrician, 49. pp. 936–942, Oct. 3, and pp. 986–990, Oct. 10, 1902.)—*System:* Power is generated at 7,500 volts two-phase and transmitted to substations, in which it is transformed to 200 volts for light and power, and converted to direct current at 500 volts for traction. The boiler-room contains eight Babcock and Wilcox boilers, each capable of evaporating 12,000 lbs. of water per hour. Superheaters of the same make are provided. The boilers have each a heating surface of 4,780 sq. ft., and the superheaters 454 sq. ft. There are three motor-driven Weir feed pumps, and a Babcock-Wilcox water-softening plant. Coal is stored in bunkers over the stoking-floor, having a capacity of 900 tons, and is fired by chain-grate stokers, provided with travelling shoots and weighing machines. The coal and ash are

Digitized by Google

handled by means of Hunt elevators and conveyors. The engine-room contains two Ferranti engines of 1,800 i.h.p. each, having cylinders 25½ and 51 in. diameter and a stroke of 21 in., running at 166 r.p.m. There is also a Yates and Thom engine of 2,500 i.h.p., running at 90 r.p.m. All the engines are fitted with automatic expansion gear and forced lubrication. A separate surface condenser, with Edwards air-pumps, is provided for each set. Each engine drives directly a Ferranti two-phase alternator, the two smaller machines generating 800 kw. each, and the large one 1,500 kw., at 7,500 volts, 50 cycles per second. The flywheels of the smaller sets are of special interest; the hub is shrunk on the crank-shaft, and the rim, which consists of one piece of cast iron, is secured in place with radial bolts, screwed into the hub tightly while hot. The flywheels carry the magnet pole-pieces on their peripheries. The switch gear is of novel pattern; it is of the oil-break type, the final break occurring at 14 contacts in series under oil. The fuses are a modified form of the Ferranti oil-break fuse, and, like the switches, can be withdrawn bodily from the switchboard, being contained in porcelain boxes. The ammeters are also of special design, and are inserted in the high-pressure circuits. The whole of the switch gear is of the single-pole type. The feeders are of the three-core two-phase type, the common conductor surrounding the other two. The largest feeders have inner conductors of 0·14 sq. in. cross-section, and an outer conductor of 0·2 sq. in. The latter, as well as the lead sheathing, is earthed at the generating station. The insulation consists of paper. The cables are not armoured; they are laid in earthenware troughs filled up with pitch. Special provision is made to provide against subsidences, which frequently occur in the district. The high- and low-pressure distributors are concentric, lead-covered and paper-insulated, and are laid in the same way as the feeders. All the cables are made by the British Insulated Wire Co., Ltd. The substations are equipped with switch-gear for the feeders similar to that already mentioned; the remainder of the switch-gear is of ordinary type. The Bilston substation is fully described; it is equipped with step-down transformers, 2 rotary converters for the tramway supply, each of 250-kw. output at 600 r.p.m., and a negative booster. The whole of the power for working the Wolverhampton and District Tramways, which comprise 10 miles of route, is taken from this substation. The energy is measured by three meters in series. Ordinary consumers are supplied with two-phase current at 200 volts, for which the tariff is either 4½d. per unit, or 6d. and 3d. on the maximum demand system, for lighting, and 1½d., or 8d. and 0·285d. on the maximum demand system, for power. The article is fully illustrated. A. H. A.

370. *Dunedin Electric Tramways.* (Tram. Rly. World, 12. pp. 524–530, Oct. 9, 1902.)—The Dunedin City Corporation Tramways are now being converted from horse-traction to electric by Australian engineers. There are 20 miles of single track on 18¼ miles of route, with average gradients. Transmission at 15,000 volts from water-power plant is planned, but steam is being temporarily used. Transition curves have been so plotted that a standard type of points can be adopted throughout. The rails are 92 lbs. girder type in 40-ft. lengths, with 30-in. fishplates 61 lbs. per pair, and are bonded with Edison-Brown plastic bonds equal to 500,000 circ. mils. section of copper. Their composition is specified: Carbon, 0·45 to 0·55, silicon 0·06 to 0·1, manganese 0·85 to 0·95, sulphur not to exceed 0·08, phosphorus not to exceed 0·06. Solid-drawn seamless steel poles are used, and No. 00 B & S hard-drawn copper trolley wire. Alternate poles carry "Bremner" 7-ampere arc lamps. There are five Callender feeders, 0·4 and 0·25 sq. in. section, in earthenware conduit. Brill

Digitized by Google

trucks with 6 ft. 6 in. wheel base, hand-brakes and Westinghouse electro-magnetic track-brakes are fitted. Motors are No. 80 Westinghouse, 2 per car, with No. 210 controllers. E. H. C.-H.

371. *Vouvry Water-power Electric Works.* **A. Dumas.** (Génie Civil, 41. pp. 389–393, Oct. 18, 1902.)—These works, established on the left bank of the Rhone, a little above the point at which it empties itself into the Lake of Léman, utilise the fall of the Lake of Tonay. The total head utilised is 950 m., which is 50 per cent. higher than the highest fall hitherto used. The normal power available in the water is 3,114 h.p., or 27,278,640 h.p.-hours per annum. The power-house has been constructed to assist another, owned by the same company, situated at Vuargny, on the other side of the Rhone, actuated by a fall of 200 m. in a tributary of "la Grande Eau." The electrical energy generated is distributed to a large number of villages in the Rhone Valley. The lines already erected have a length of 127 km. and feed 68 substations. The number of lamps supplied is 20,000 of 8 c.p., and motors aggregating 450 h.p. The generating plant consists of Pelton wheels of 500 h.p., running at 1,000 r.p.m., mounted directly on the shafts of alternators. The latter are of the single-phase type, each having an output of 60 amperes at 5,500 to 6,000 volts with a frequency of 50 cyles per second. The total cost for the first 2,000 h.p., including water rights, was 800,000, or 400 francs (£32) per h.p. The 2,000 h.p. now in course of erection, necessitating only the construction of a new conduit 340 m. long, and four new generating sets, will only cost 800,000 francs, bringing down the cost per h.p. for the whole station to 275 francs (£11) per h.p. The article is devoted principally to a description of the hydraulic details of the installation, and is well illustrated. F. B.

372. *Central Station of the Société Electricité et Hydraulique in St. Petersburg.* **W. Multhauf.** (Elektrotechn. Zeitschr. 23. pp. 585–589, June 19, 1902.)—This is one of three large central stations supplying electrical energy in St. Petersburg. It contains 23 water-tube boilers of 265 to 300 sq. m. heating surface working at 12 atmospheres with four different chimneys 50 m. high and 2·25 m. diameter at the top. The generating plant consists of 15 direct-coupled sets of 350 kw. each, the station being large enough for 20 such sets. The large number of comparatively small units was chosen in order to reduce the inconvenience arising from the breakdown of one set while the smaller engines and machines can be more readily repaired in the station workshops. The switchboard is arranged with a complete double ring of bus-bars, interrupted at various points so that any section can be cut out when repairs are necessary. One pole of all generators is connected to earth as well as the outer conductors of all cables. A. E. L.

373. *Power Transmission from Evenstad Falls to Arendal and Grimstad.* (Elektr. Tidsskr., Christiana, 15. No. 29, p. 181, Oct. 17, 1902.)—At Evenstad Falls two 1,250-h.p. turbines running at 125 r.p.m. are being installed for a beginning. Ultimately about 8,000 h.p. will be developed. Two direct-coupled, three-phase, 2,000-volt, 1,000-kw. generators act as flywheels to the turbines, each having a weight of about 40,000 kg., and being 5 m. in diameter. Two 50-h.p. exciter machines are being installed beside the large generators, and fitted with special turbines. From the generators the current is led to six single-phase, 340-kw., 2,000–17,000-volt converters. The total length of the transmission conductors is somewhat over 30 km. It is intended to supply electric light and power to the district adjacent to the line. At the distribu-

Digitized by Google

tion points the high-voltage current is first transformed to 2,000 volts, which is to be directly used with the larger motors. For lighting purposes and smaller motors there is to be a further transformation to 220 volts. A. G.

374. *Cascade Water-power and Light Company's Power Transmission.* (Electrical Times, 22. p. 451, Sept. 18, 1902.)—The power is drawn from the Kettle River at Cascade City, where, within a distance of half a mile, the river has a natural fall of 121 ft. It is employed for lighting and power supply to various factories and mines within a radius of about 21 miles. A dam of timber cribwork and rock has been thrown across the river at the head of the gorge, and raises the available head at low water to 156 ft. The dam is 400 ft. long. It varies in height from 50 ft. at the centre to about 25 ft. at the banks, is 40 ft. wide at the base, tapering to 24 ft. at the top, and is set firmly throughout on the bed rock, to which it is secured by bolts. The normal working level of the water is 10 ft. below the top of the dam, and at times of flood the excess of water is passed away through twelve sluice-ways, which can be opened down to 12 ft. below the normal water level, giving a maximum area of about 2,000 sq. ft. of water-way. The doors of the sluice-ways consist of a series of logs of 12 in. by 12 in. section, resting one above the other. As the water rises in flood-time, the sluices are opened by raising the logs as required; for this purpose an electrically driven winch, mounted on a carriage and travelling over a railway on the top of the dam, is utilised. The water passes from the river behind the dam into an open channel cut into the rock, which, after continuing for a distance of 225 ft., merges into a closed tunnel hewn through the rock for a distance of about 410 ft. The water-way continues as an open rock channel for a length of a further 500 ft., where it terminates at a massive concrete bulkhead, and the pipe lines are met. Each pipe line, for the greater part of its length, is built up of fir staves, bound barrel-wise by hoops 12 in. apart. The staves are each 2¼ in. by 7 in. section, machined to a segmental form, and bound by ¾-in. steel hoops or bands, fitted with adjustable tightening bolts. The pipe line is 7 ft. in diameter, and provision has been made at the bulkhead for a second line 8 ft. in diameter of similar construction. The total length of the pipe is 1,650 ft., of which the upper 1,400 ft. is of the stave construction mentioned. The lower length of 250 ft. is built of steel, and terminates at the turbines. The power-house is at the foot of the falls. The main generating plant consists of two horizontal turbines, each direct-coupled to a Westinghouse three-phase alternator of 750-kw. capacity. The current passes from the alternators direct to step-up transformers for transmission at high pressure to the several surrounding towns and industrial centres. G. W. DE T.

375. *The Lagos Central Station.* C. Hohl. (Elektrotechn. Zeitschr. 23. pp. 747–748, Aug. 21, 1902.)—The boilers and engines are by Davey Paxman, and the 80-kw., 1,000-volt, single-phase alternators by The Electric Construction Company. The lighting is carried out at 100 volts. About 40 km. of bare overhead wire, 6·8 sq. m. section, have been erected. The price of current has been fixed at 8d. a unit, and Welsh coal is employed, costing 50s. a ton, delivered free at Lagos. E. K. S.

376. *Manchester School of Technology.* (Engineering, 74. pp. 466–476 and p. 478, Oct. 10, 1902.)—This is a description with diagrams and photographs of the Engineering, Electrical, Chemical, and Textile laboratories, the Electric Supply Station, and the Engineering Workshop. The boiler-room contains

Digitized by Google

one Babcock and Wilcox water-tube boiler which will give steam for 160 h.p. under natural draught and about 200 h.p. under forced draught; one return-tube boiler by Messrs. Rollo, of Liverpool, giving steam for 800 h.p. with natural and 450 h.p. with forced draught; and one small tube, express, Reed boiler of about the same duty as the return-tube boiler. The first two are fitted with mechanical stokers. There is also a Schmidt superheater having 400 sq. ft. of heating surface. The supply station engine-room contains four 100-kw. sets consisting of (1) a slow-speed side by side compound engine by Marshall, of Gainsborough, driving by rope-gear a four-pole shunt-wound dynamo by Scott and Mountain; (2) a Burnett-Lindley compound engine driving directly a Mather and Platt shunt-wound dynamo; (3) a Willans engine driving a Bruce-Peebles dynamo; (4) an American tandem compound overhung-crank engine, by the Robb Engineering Co., driving directly a four-pole dynamo by Dick, Kerr & Co. There is also a 50-kw. Parsons turbo-electric generator. The exhaust steam from the engines is used for heating the building. There is a balancer and booster set by the Lancashire Dynamo and Motor Co.—balancers being required because the distribution is by the three-wire system, and the boosters being used for charging the cells, the latter having a storage capacity of 600 ampere-hours. The Electrical Laboratory contains a large number of smaller dynamos and motors of various types, both continuous, alternating, and polyphase; the test-rooms are equipped with instruments which will deal, for standardising purposes, with currents up to 4,000 amperes and pressures up to 100,000 volts. The Engineering Laboratory includes laboratories for materials testing, machine testing, hydraulic apparatus, gas and oil engines, and steam engines. The gas-engine laboratory contains two gas engines (a "Crossley" and a "National") and three oil engines (including a "Diesel"), also two refrigerating plants. The experimental steam engine in the steam-engine laboratory is a horizontal compound, capable of 350 b.h.p. Cylinders 11¼ in. and 20 in. diameter by 36 in. stroke, suitable for initial pressure up to 250 lbs. per sq. in. and speed up to 110 r.p.m. There are two interchangeable cylinders of each size, the smaller ones having Sulzer or Corliss valves and the larger ones Meyer or Corliss. The power is measured by a band brake, the band consisting of two hoops of steel riveted together with a very narrow space between, through which the cooling water circulates; there are beech slabs bolted all round the rim of the wheel. The pulls on the tight and slack sides of the band are applied on opposite sides and 1 ft. from the fulcrum of a lever; the weights and a cylinder containing a quantity of water, which is varied by a special governor according to the torque the engine is exerting, being hung at 18 ft. 9 in. from the fulcrum. H. R. C.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

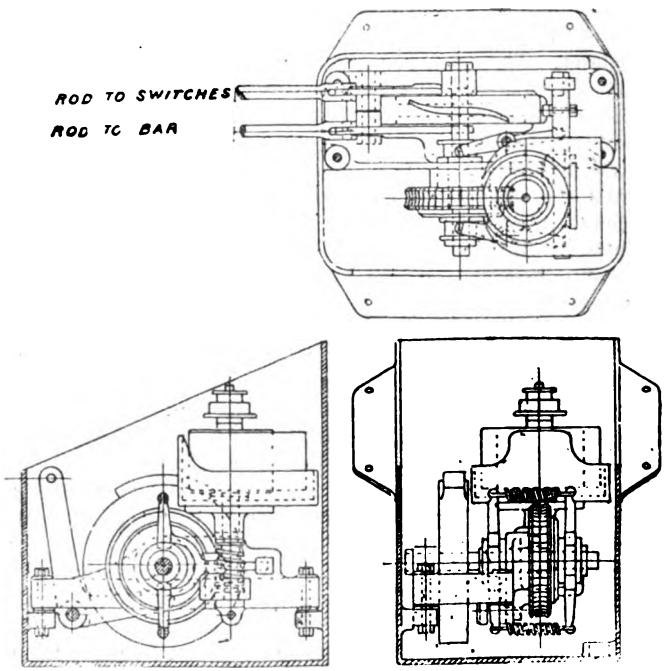
377. *Automatic Circuit-breaker for Trolley Wires.* (Génie Civil, 41. p. 417, Oct. 25, 1902.)—The device described is devised by G. Bellangé, and is in use on tramways in the suburbs of Bordeaux. It is intended to prevent accident due to breakage of the overhead wire. From the various brackets a small porcelain box is suspended, partially filled with mercury, and capable of oscillation about its point of support. The trolley wire is led into the box at each end, and cut inside, the current being conveyed by the mercury between

[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

Digitized by Google

the two ends. In case of a breakage of the overhead wire, the box is tilted about its point of support, and the mercury no longer makes contact with one end of the trolley wire, the current being therefore cut off at this point. The bottom of the box is furnished with a skate-like projection to facilitate the passage of the trolley. W. H. S.

378. *The "Crewe" System of Railway Signalling.* (Elect. Rev. 51. pp. 903–908, Nov. 28, 1902.)—In the cabins there are two tiers of levers, one for points and the other for signals. The motors for the points and the electromagnets for the signals are worked from the station lighting equipment at 110 volts. In the largest cabins 50 amperes would be the largest demand, say for 200 levers. At a facing point there is an electric motor

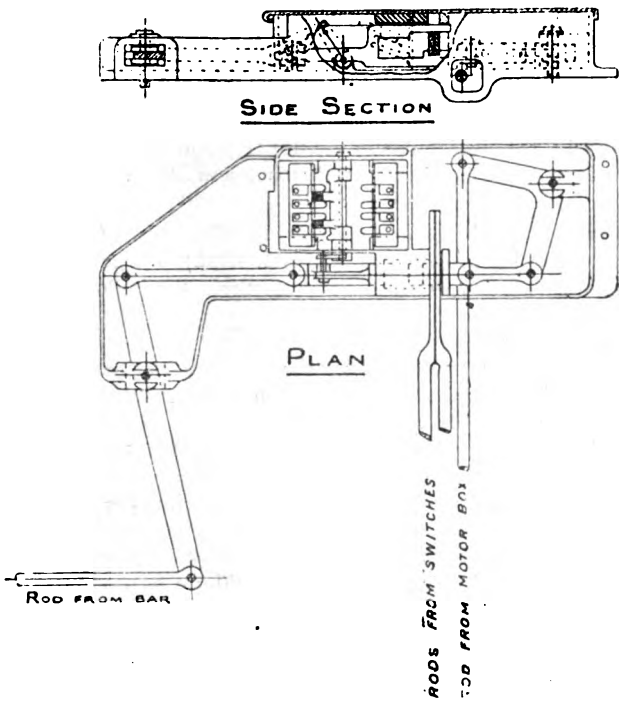


ELECTRIC MOTOR FOR WORKING POINTS, AND FACING POINT LOCK.

working through a worm gear with a right- and left-handed clutch for working the switch and locking rod, electrical switches in the cabin for starting and reversing this motor, and detector arrangements so that the signal cannot be raised, or electrical connection made with the electromagnet for working the signal, until the point is bolted in a preconceived position. For throwing a point a corresponding switch is pulled about halfway over and stopped by the check lock. This motion establishes connection with the electric motor through a carbon-break switch. The motor rotates and carries the point over. Until the point is over and the locking effected, the full throw of the operator's handle cannot be accomplished. When, however, the point is fully over, and the locking established, electrical connection is made through a solenoid which releases the lever, so that the approximate signal can be placed at safety. There is, therefore, a double safeguard as regards the signal, one by the check lock, and the second by the

Digitized by Google

electrical connection. By the use of worm gear and a cam, in addition to the bolt lock, a further locking of a point is effected, since neither the worm gear nor the cam can be reversed from the point—an important advantage, since it has sometimes occurred that the bolt lock has failed. In this event the point would be firmly held by both the cam and the worm gear. The armature is formed on a tube which fits over the armature shaft, and it can be lifted off and a new armature substituted in a few minutes. The armature shaft is provided with ball bearings, and drives a worm and worm-wheel. The worm-wheel is loose on a cross-shaft, and its movement is transmitted to the cross-shaft by means of two clutches, one on either side; these clutches are made right- and left-handed, so that if the worm-wheel is turned in one direction, one clutch will be engaged, and will turn the cross-shaft, say,



SWITCH BLOCK FOR FACING POINTS.

to the right; in the opposite direction the other clutch will be engaged, turning the cross-shaft to the left. When the point has been moved over and bolted a striking gear is operated, which disengages the clutch, and the motor then runs free until it stops. Keyed to the cross-shaft is a cam-wheel, on either face of which is formed a cam-shaped slot of an irregular contour; in each slot there works a roller attached to a bell crank, the one crank working the point, and the other the locking bar and bolt; this locking bar and bolt is only required for facing points, in the case of trailing points the one crank only is needed. The motor and its mechanism are placed in a cast-iron box with a cover, which is level with the top surface of the sleepers. The box is filled with thick mineral oil to the level of the cross-shaft, and thus the mechanism is automatically and continually supplied with lubrication; one charge of oil has in practice been found to last for eighteen

Digitized by Google

months, when a little fresh oil must be added. In the side of the box is formed a siphon, so that should any water find its way into the box it would fall to the bottom of the oil, the level of which would be raised, and the water at once siphoned away. Very little water in practice is found to get into the box, but in the event of a box being filled by accident, the siphon being inoperative, no harm results if the water is cleared off in the course of twenty-four hours. The arrangements of the motor and rods, as well as those of a switchblock are shown in the diagrams. The motor takes 20 amperes at 100 volts, speed 800 revs., the points moving over in about 3 secs. For signalling Timmis's movement with "long-pull" electromagnet is employed; it takes 6 amperes at 100 volts for a fraction of a second to pull the arm to the "off" position, when the switch passes this current through a resistance reducing the current to about 2 amperes to hold arm. From experience of three years the electric system has shown greater reliability than exists with pneumatic or hydraulic systems, in that there is nothing to condense or freeze and fewer working parts; greater simplicity, since the ordinary power plant supplies the power for working, and there are no valves, cocks, &c., incidental to the use of pneumatic or hydraulic power. It is also easy to extend, and the maintenance less costly. E. O. W.

379. *Signals for Urban and Interurban Railways.* **G. W. Palmer.** (Street Rly. Rev. 12. pp. 780–781, Oct. 11, 1902.)—A general view of the reqirements for a block system. Among others the following are prominent:—

A signal to be reliable and efficient should be quick and positive in action; it should be impossible to set the cautionary or permissive signal at near end of the block before setting the danger indication at the far end; incandescent lamps should not form a part of the main signal circuit, nor should the lighting and extinguishing of lamps be the only visual indication of the signal. This should be supplemented by the movement of an arm or semaphore blade, which will move each time the signal is operated whether the lamps burn or not. The device will then be operative if the lamps burn out, as sometimes will happen. Manual control affords unauthorised persons a chance to interfere with the signal, and should not be used; the setting and clearing circuits should be closed automatically, and when the signal has been set at danger it should lock so that it cannot be cleared until all cars have passed out of the block. It should be possible to set the signal only one way by two cars entering a block from both ends at the same time.

An improved method of operating the signal is by means of a circuit closer hung overhead and at a point sufficiently in the rear of the box, the circuit being closed by the passage of the trolley wheel; there are devices of this kind now obtainable which are reliable and effective in action.

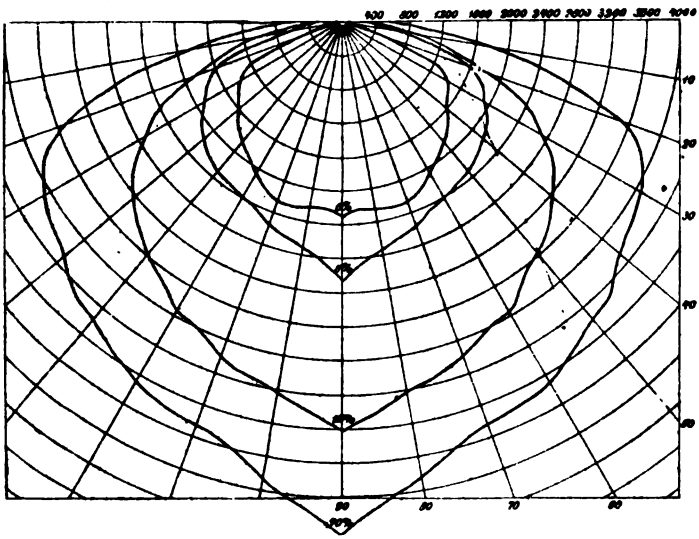
Double track roads are also feeling the need of some system which will prevent rear end collisions. Where cars are operated on quick headway, and a direct view of the track ahead cannot be had, there is always danger of a car overtaking the preceding one. This is particularly the case at night, and all cars operated on suburban lines should carry a rear end red lantern. This simple precaution is so obvious that it would seem as though it must have been adopted by every one. Such, however, is not the case.

There has been some work done along the line of cutting off the trolley current from a car which has not the right of way, thereby making it impossible for the car to proceed. This scheme seems to be a very attractive one, and it is possible that it may be effectively developed. E. O. W.

Digitized by Google

ELECTRIC LAMPS AND LIGHTING.

380. *Arc Lamps.* **W. Wedding.** (Elektrotechn. Zeitschr. 23. pp. 702–709, Aug. 7, 1902. Paper read before the Elektrotechnische Verein, May 27, 1902.)—The first section of the paper deals with so-called flame-arc lamps, in which the carbons are placed obliquely side by side. In the tests an electromagnet was placed near the arc in order to blow it in a downward direction. Under these conditions, with ordinary carbons, a voltage of 60 was necessary to produce a steady arc of 9 amperes. Other carbons were tested at the same time, the positives containing quantities of fluorspar, varying from 8 to 40 per cent. The annexed figure shows graphically the results obtained with ordinary carbons, and with others containing 8, 15, and 40 per cent. of fluorspar. Reducing the results to mean hemispherical candle-powers, the ordinary carbons took 0·458 watt per c.p., those containing 8 per cent. of fluorspar took 0·282 watt, those containing 15 per cent. took 0·162 watt, and those



containing 40 per cent. took 0·118 watt. The addition of 15 per cent. of fluorspar is recommended as being the most suitable ; a greater proportion increases the efficiency but causes irregularities in burning, produces much scoria, and gives too pronounced a yellow light. Strontium compounds give a red colour to the light, and barium compounds produce a light which is described as being of a dirty white colour with a slight tinge of green. Both of these are, however, inferior to calcium in the effects they produce. With the carbons placed obliquely side by side, there is little difference in efficiency between continuous and alternate current. For instance, with an addition of 7 per cent. of fluorspar, a continuous-current lamp takes 0·24 watt per c.p., and an alternate-current lamp takes 0·285 watt. A further series of tests was made with carbons placed in the usual way, the one above the other ; with a 7 per cent. addition of fluorspar, and an arc of 9 amperes as before, the mean hemispherical efficiency is 0·296 watt per c.p., if the positive carbon alone has the fluorspar ; if both carbons are treated, the efficiency is 0·193 watt per c.p. A larger proportion of fluorspar cannot in this case be used on account of the tendency to the formation of scoria. Curves are next given showing the dis-

Digitized by Google

tribution of light on the floor of a room in which a lamp is hung at a height of 4 m.; the ordinary type of lamp both with plain and impregnated carbons is compared with the so-called "flame" arc, which has carbons placed side by side. The difference in the distribution of light is very markedly in favour of the flame arc, especially at points immediately beneath the lamp, though these curves would require some correction for the dispersive effects of globes. A short report is appended from K. Arndt, who examined the nature of the gases which are given off from prepared carbons which had been treated with fluorspar. The gases generated in the globe of the lamp were sucked by an aspirator into a platinum dish containing distilled water. Carbons mixed with borax and with 7 and 40 per cent. of fluorspar were burnt for two or three hours, but in neither case was any trace of fluorine or boron to be found in the water in the platinum dish. Therefore there is supposed to be a complete absence of any injurious gases. The flame-arc is considered to be suitable for street lighting, but owing to the unsteadiness of the arc, it is not yet likely to be useful for internal illumination. W. H. S.

381. *Radiant Efficiency of the Arons Mercury Lamp.* **W. C. Geer.** (Elect. World and Engineer, 40. p. 86, July 19, 1902. Paper read at the Pittsburg Meeting of the A.A.A.S.)—The radiation from the lamp is allowed to fall on a thermopile, and the first throw of the galvanometer is read, which is proportional to the total radiation A. The throw, giving the luminous energy alone, a', is observed when a cell of water is placed between the lamp and the thermopile. A reading, e', to correct for the heat transmitted by the water cell is taken when a cell containing a solution of iodine in carbon bisulphide is interposed together with the water cell. Then the efficiency is given by the expression $(a' - e')/A$. The results have further to be corrected owing to the amount of heat given out by the glass, and a curve was constructed showing approximately the rate at which the glass became heated. With a voltage of about 14·5, the efficiency was found to be roughly proportional to the current, and varied from 0·305 with 3·85 amperes to 0·479 with 9·04 amperes. The figures given are not altogether concordant, but this is believed to be due to the extreme unsteadiness of the arc at the time the observations were made. A reference is given to the communications of some of the earlier workers on the subject of the mercury lamp. W. H. S.

382. *Electric Lighting of Trains.* (Revue de l'Él. Berne, 11. pp. 145–148, Oct. 15, and pp. 154–156, Oct. 30, 1902.)—These articles describe the Kull system, as carried out by Brown, Boveri & Co. Each carriage has a dynamo and small battery. A centrifugal regulator switches in the dynamo when the train reaches a certain speed, and inserts a gradually increased resistance in series with the magnet winding as the speed increases. The voltage of the dynamo is kept constant at any speed between 650 and 2,320 r.p.m. An automatic cut-out opens the circuit of the dynamo when the battery is fully charged or when the speed falls too low. Diagrams of the electrical connections and other drawings are given. W. H. S.

383. *An Incandescent Lamp Photometer.* (Electrician, 49. pp. 954–955, Oct. 8, 1902.)—This photometer, manufactured by Everett, Edgcumbe & Co., is a form of the Leeson disc photometer. It is provided with a standardised lamp of the proper voltage, and when the balance has been obtained the candle-power is read directly off a logarithmic scale. It is unnecessary to keep the voltage constant during the test; both the lamp under test and the standard lamp are run off the same voltage, and any variations will affect both equally, the point of balance therefore remaining unaltered. W. H. S.

Digitized by Google

TELEGRAPHY AND TELEPHONY.

384. *The Rowland Rapid Telegraph System.* (Elect. World and Engineer, 40. pp. 616–619, Oct. 18, and pp. 653–654, Oct. 25, and pp. 696–698, Nov. 1, 1902.) —This system was described in Abstract No. 2059 (1901), but diagrams may be shown, with advantage, of some of the arrangements, say for four operators. It is found that 208 alternations of current can be used per second and the distri-

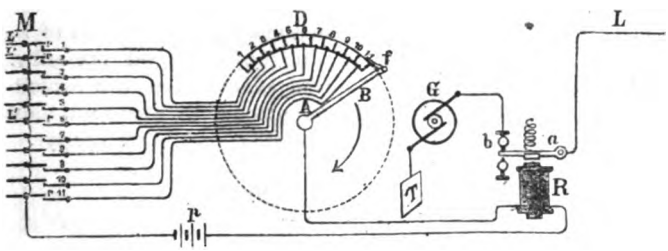


FIG. 1.—TRANSMITTER.

butor contacts can be provided accordingly. The signalling may be effected by cutting out two half-waves, not adjacent, in a group of 11 half-waves allotted to each operator successively, with an extra half-wave between the groups. The 11 half-waves permit of 45 possible different signals. The movement of the distributor is so rapid that although the signals are actually successive,

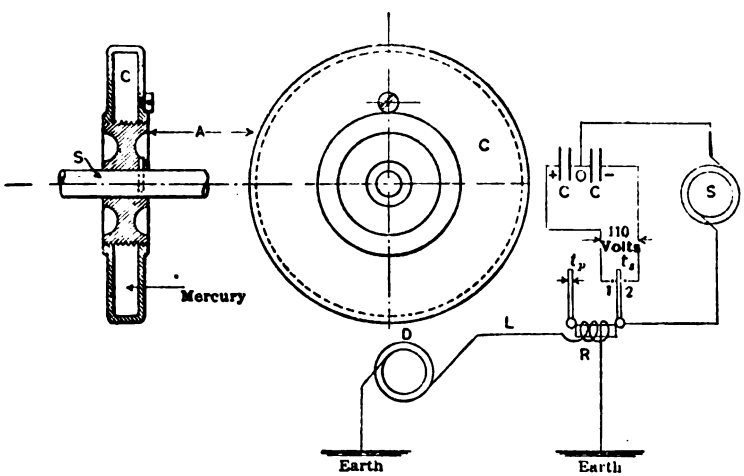


FIG. 2.—SYNCHRONISER.

the four different operators appear to be sending four different signals simultaneously. Fig. 1 shows the sending arrangement, M being the keyboard, on pressing any key of which two levers are actuated and are brought into connection with two divisions on the distributor, *f* is a metallic rubber or brush, by means of which relay R is closed by battery P. The method of securing synchronism is shown in Fig. 2. L is the line by which the

Digitized by Google

alternations are receiving from the distant station, R a polarised relay whose tongues are in constant vibration, S a small synchronous motor on the same shaft of which is the aluminium wheel A. In this wheel is a channel C completely filled with mercury. By virtue of the charge and discharge of the condensers CC the small motor is kept running in synchronism with the alternator D. Any oscillations or "pumping" is damped by the mercury revolving at a uniform velocity and acting by friction on the wheel. The other tongue t_2 makes the local contacts for printing as shown in Fig. 8, C being the "receiving" commutator, S the synchroniser, and t_3 a trailer. The alternating current from the station of origin is received by a polarised relay. It has two armatures which are constantly oscillating under the action of the current. The first plays between the + and — poles of a battery, the middle point of which is connected to the common junction of a row of "combiner" relays whose function will be described presently. This armature is also connected at another point to the arm which moves circularly over a distributor disc in which metallic pieces are set, these pieces being connected to the other terminals of the "combiner" relays. As this

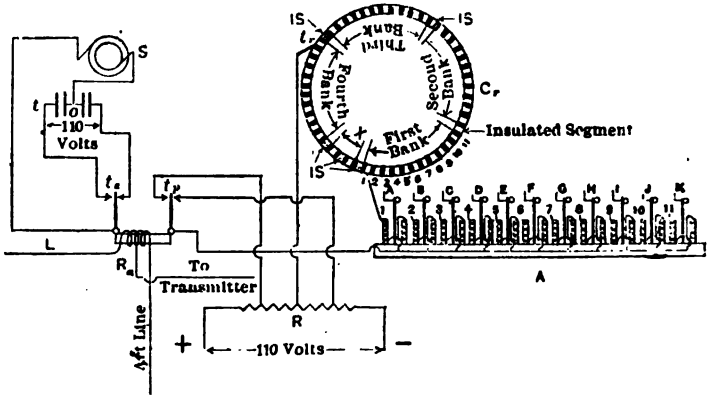


FIG. 8.—DIAGRAM OF CIRCUITS AT ONE STATION.

arm moves quickly round, being driven by a motor working synchronously with that at the station of origin, + and — currents are of course successively sent through the coils of the "combiner" relays. The connection is oppositely made in each relay, and as they are wound alike, the current successively + and — has a similar effect upon each, and all their tongues remain on the rest contacts so long as the current waves suffer no disturbance. But should a half-wave be suppressed, which, as has been seen, is effected for signalling purposes at the station of origin, the relay connected to the contact of the disc at that moment touching the arm, is influenced and the tongue comes over to the working stud. Thus a local circuit can be brought into play, causing the proper letter to be printed. For each signal, two armatures of the "combiner" relays are brought into play by the suppression of two non-successive half-waves, the first makes contact and the second breaks it, and, during the interval, the mechanical movement of the type has time to operate, such intervals being of equal durations. To provide for the requisite movements of the sheet of paper upon which a communication is printed at the receiving end of a line, there is added a third crown or wheel of contacts, traversed by a third metallic brush or contact-maker. When any two of the armatures of the "combining" relays are against their

Digitized by Google

working stops as a result of signals sent from a distant station they constitute part of a closed circuit with the "combiner" discs, two brushes bearing upon them, a battery and one bobbin of a local polarised relay. There are four of these relays, each having for its function to actuate a local electromagnet of its own. The first raises a little hammer at the right moment against the paper and causes the latter to press against the type letter. When this takes place, were the type-wheel to continue to move round on its own axle, the imprint would be smudged, consequently the type-wheel is not rigidly fixed but can be detained for a moment against the tension of a spring, which recoils directly the little hammer is released, and the type-wheel again regains its normal position on its own axle. The second electromagnet serves to move the paper from left to right after each impression making the proper intervals. Its armature is furnished with a click working upon a ratchet attached to the drum actuating the paper, a corresponding drum from which the paper is unwinding containing a recoil spring which comes into play when a line is completed. The third electromagnet is employed to effect the disengagement of the ratchet, and the paper is drawn back to its full length from right to left. The fourth electromagnet has for its function to move longitudinally the drums upon which the paper moves, in order to commence a fresh line. These four electromagnets, through the agency of their own and the "combiner" relays, working off the "combiner" discs and the "distributor," are caused to operate by the movement of appropriate keys at the station of origin, so that the movements of the paper are entirely under control of the sender. Apart from the mechanical functions of the armatures of these magnets, each has a local contact, which serves, when the mechanical operation has been performed, to send into the second bobbin of its own local relay a current of restitution to the normal or rest contact of the relay tongue. The four receivers, when so many are employed, or fewer if desired, are driven on one arbour by an electromotor; this arbour is mechanically independent of the axle of the receiving distributor, but it is indispensable that the brushes of the combiners and the type-wheels should be in synchronism with the former. Thus by adjustable resistance in the motor circuit the speed is made the same. The axle of the distributor has also a little disc at its extremity composed of three segments insulated from each other, and a metallic arm connected with the arbour before mentioned rides upon the periphery of this disc. Should the arbour fall behind the distributor in speed the arm comes into contact with a segment of the disc which is arranged to cut the resistance out of the motor circuit, and the motor then quickens. But if the opposite effect occurs the arm moves forward to another segment, in connection with which is an electromagnet receiving current where this current occurs, from the source supplying the motor. Between the poles of this magnet revolves a copper disc driven rapidly by the same motor by appropriate gear. The result of closing the circuit of the magnet is to retard the motion of the disc and to slow the motor, thus causing the arbour of the receivers to come back to synchronism. In point of speed the rendering of the apparatus is limited by the time taken to move mechanically the recording paper. A rate of 40 words per minute for each of four operators is said to be possible, or 160 words for the four, and in duplex very much more, of course, can be done. E. O. W.

385. *The Military Cable System of the Philippines.* **E. Russel.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1319–1331; Discussion, pp. 1424–1432,

Digitized by Google

Oct., 1902.)—Many of the routes were imperfectly charted. The lines of route were therefore sounded with the Sigsbee machine, utilising piano wire and an iron detachable sinker. In 1,200 fathoms the latter, which failed to be detached, was found on pulling up to be ice-cold, showing the deep-sea temperatures in the torrid and frigid zones to be similar. In most stations single- and double-current Morse working with polarised relays was adopted, but the men were also instructed in the use of cable recorders and automatic transmitters, which it is also proposed to use in busy hours. In wiring offices, ordinary "office" wire could not be depended upon, and rubber covering was found essential for climatic reasons. Submarine cables have rubber insulation, this material being adopted in preference to gutta owing to the necessity of transportation and storing, with consequent exposure of the cables, subject to conditions under which gutta would become worthless. On immersion, the rubber showed improvement as it went down. The two types of cable employed were as follows :—

Conductor.	A. Seven No. 24 Copper.	B. Seven No. 21 Copper.
Diameter of Insulation.	8/32"	9/32"
Copper Resistance per knot	21·6 at 70° F.	9·7 at 60° F.
Dielectric " " "	1400 Meg. at 60° F.	750 Meg. at 75° F.
Capacity " " "	0·38 m.f.	0·38 m.f.
Armour	16 No. 12 steel wires.	16 No. 10 steel wires.
Approx. weight per knot.	1·3 tons.	1·75 tons.

The core in each was taped, served with a double layer of jute, armored, then served with a double layer of jute, and finished with a covering of compound and soapstone. The shore end cable was similarly made, but received an additional armor of 18 No. 6 steel wires and another double layer of jute and compound. This shore end weighed about 6½ tons per knot.

E. O. W.

386. *De Forest Wireless Telegraph System.* (Electrician, 49. pp. 943–944, Oct. 3, 1902.)—The receiver in this system consists of a telephone and battery in circuit with two electrodes of soft metal separated by a paste consisting of an electrolysable fluid, metallic particles, and some viscous material. The resistance is ordinarily small, but when acted on by an e.m.f., the electrolytic production of hydrogen bubbles at the kathode causes a sudden increase. The oxygen appears to combine with the anode, and the hydrogen is rapidly absorbed by a depolariser in the paste, which should be renewed about every third day. The receiver is said to be sufficiently sensitive to respond to a $\frac{1}{64}$ in. spark, 45 ft. away, with antennæ only 2 ft. high. Alternating current at 500 volts and 60 $\sim$ is used for transmission, with a make and break key. This current is transformed up to 25,000 volts, and applied directly to a double spark-gap shunted with a Leyden jar battery, six to eight quart jars in parallel being used in the case of a 1-kw. generator. Each spark-gap is about ¼ in. long, and the terminals are disc or mushroom-shaped. A speed of 40 words a minute is stated to have been attained over distances of 50 to 60 miles, and as much as 48 words a minute over shorter distances. About 95 per cent. of the messages transmitted were perfectly received.

G. W. de T.

Digitized by Google

SCIENCE ABSTRACTS.

Section B.—ENGINEERING.

MAY 1903.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

387. *Smokeless Calorific Furnace.* (Eng. and Mining Journ. 74. p. 685, Nov. 22, 1902.)—This article gives a description, with sectional elevation, of a specially constructed furnace for burning powdered fuel with a view to steam-raising. The flame is baffled, and the openings for admission of a secondary supply of air from a hollow bridge are arranged, so that none of the dust shall escape unconsumed. F. J. R.

388. *Economisers.* **H. F. Schmidt.** (Amer. Electn. 14. pp. 518-519, Nov., 1902.)—The temperature of the flue gases escaping from any boiler must necessarily be higher than that of the steam and water in the boiler, unless a section is isolated as to steam connection, and contains only water to feed the other portions. In order to aid in estimating the heat carried off by these waste gases, this paper contains a table showing such heat losses at temperatures of from 200° F. to 700° F., and with different volumes of air supplied to the fires, from 350 down to 150 cub. ft. per lb. of Cumberland (American) coal of an average thermal value of 12,230 B.Th.U. A second table shows the saving in B.Th.U. per lb. of combustible used which is due to reducing the temperature of the flue gases down to 275°, 325°, and 375° F. respectively —the same coal and the different quantities of air used in the former table being also taken in this one. The advantage of using economisers is easily deduced from these. The question of draught-production was dealt with in a former paper [see Abstract No. 1180 (1902)]. Some practical points as to the construction and working of economisers are given in the present paper. F. J. R.

389. *Efficiency of Non-conducting Compositions.* **T. H. Beare.** (Mech. Eng. 10. pp. 391-392, Sept. 20, 1902. Abstract of a paper read before the Royal Scottish Society of Arts.)—The experiments referred to—extending over three years—were carried out with wrought-iron steam piping 8 ft. 10⅛ in. long and 3·53 in. mean external diameter, average thickness

Digitized by Google

of metal being ¼ in. Total area of external surface of the uncovered pipe was 8·132 sq. ft.

SUMMARY OF RESULTS.

Kind of Covering.	Thickness of covering. Inches.	Weight of 1 cub. ft. of covering loose. Lbs.	Weight of 1 cub. ft. of covering on pipe dry. Lbs.	Steam pressure by gauge. Lbs. per sq. inch.	Temperature. Fahr. Steam in pipe.	Air in room.	Outside of covering.	Loss of heat. B.T.U. p. sq. ft. external surface, uncovered pipe per hour.	Condensed steam. Lbs. p. sq. ft. external uncovered surface per hour.
Series A.									
Uncovered pipe	—	—	—	3	223	64·5	—	360 3	0·376
,, ,, ...	—	—	—	59	306	62·4	—	697·0	0 775
Series B.									
Uncovered pipe	—	—	—	46·5	294	94	—	564·0	0 622
Asbestos, No. 1	1·42	39	49·8	45	292	61·9	125	213·3	0·235
,, No. 2	1 39	—	—	45	292	59·3	115	192·9	0 202
,, No. 3	1·42	28·6	38·9	45	292	56·8	108	172·1	0·189
,, No. 4	1·54	22·7	33·6	46	293	65	—	134·0	0·148
,, ,, ...	1·43	22·7	33·6	47	294	68·5	116	147·3	0·162
Fossil meal composition	1·40	73 8†	47·5	44	291	61·3	112	182·1	0 201
Patent non-conducting composition	1·38	22·5	38·3	47	294	63 7	120	168 9	0·186
Series C.									
Uncovered pipe	—	—	—	80	324	66	—	767·0	0·866
,, ,, ...	—	—	—	86	328	68·3	—	775·0	0·878
Asbestos, No. 1	1·42	39	49·8	70	323	59·9	132	262·4	0·295
,, ,, ...	1·50	—*	—*	80	324	61	135	202 6	0·229
,, No. 2	1·39	—	—	76	321	60·7	123	221·4	0·250
,, No. 3	1·30	—*	—*	68	327	67	116	163·5	0·185
,, ,, ...	1·42	28·6	38 9	79	323	59·4	119	192·0	0·217
,, No. 4	1 54	22·7	33·6	79	323	66·2	—	168·3	0·190
,, ,, ...	1 43	22·7	33·6	80	324	62·6	118	180·9	0 204
Fossil meal composition	1·30	—*	—*	81	325	79	140 8	232·0	0·262
,, ,, ,, ...	1·40	73·8†	47 5	78	322	65 6	130	207·5	0·234
Patent non-conducting composition	1·38	22·5	38·3	80	324	64·1	130	192·0	0·217
Mica sectional covering	1·14	—*	—*	80	324	80	114·5	134·7	0·152
Series D.									
Uncovered pipe	—	—	—	135	358	67	—	908 0	1·050
Asbestos, No. 1	1·50	—*	—*	149	365	62	131·8	271·7	0 318
,, No. 8	1·30	—*	—*	137	359	75	120	208·0	0·242
Fossil meal composition	1·30	—*	—*	134	358	78	163	252 5	0·293
Mica sectional covering	1·14	—*	—*	130	355	79	119·4	150·3	0·174

* In the case of these experiments the weight of the covering when dry upon the pipe per sq. ft. of external surface of pipe uncovered was determined by careful measurement and weighing. The results are as follows :—

Asbestos, No. 1	10·2 lbs.	per	sq.	ft.	of	pipe surface.
,, ,, 2...	7·4 ,,	,,	,,	,,	,,	,,
Fossil meal composition	8 24 ,,	,,	,,	,,	,,	
Mica sectional covering	4·73 ,,	,,	,,	,,	,,	

† Wet.

The durability of the various coverings was not tested, time and practical experience being required to determine this factor. Regarding the heat losses per degree of difference of temperature between steam and air, the author points out that the uncovered pipe experiments—excepting those at 8 lbs. steam pressure—show an average of 2·96 B.Th.U. per sq. ft. of external surface with the thickness of pipe used. For the usual thicknesses this may be taken at 3, and heat loss may be readily calculated for any area and steam pressure. For the mica sectional covering of the thickness employed, the average loss works out at 0·548 B.Th.U. per sq. ft. of surface. For Asbestos

Digitized by Google

No. 4 the average loss with thickness of 1·54 in. is 0·621 B.Th.U., and for a thickness of 1·48 in. the loss is 0·672 B.Th.U. For Asbestos No. 1, with 1·5 in. thickness, the loss is 0·888 B.Th.U., and 1·42 in. thickness the loss averages 0·962 B.Th.U., a difference of less than $\frac{1}{10}$ in. showing a considerable difference in the amount of loss. [See also Abstracts Nos. 947 (1902) and 7 (1903).] F. J. R.

390. *Recording Apparatus for Testing Engine Governors.* **J. C. Riley.** (Amer. Soc. Mech. Engin., Trans. 24. No. 0971, pp. 1–21, 1902.)—This paper contains a detailed description, illustrated by diagrams and photo blocks, of a method employed at the Engineering Laboratory of the Massachusetts Institute of Technology. The method was specially designed to be used in cases where the governor is, owing to its position, practically inaccessible when the engine is running; in the case in question, the governor was on the main shaft. A metal pointer attached to the movable "pendulum" (by which, through an eccentric, the piston value of the high-pressure cylinder was actuated) traversed a compound block composed of alternate strips of brass and ebonite fixed to the flywheel; from the pointer, and from each brass strip, a wire was carried down an arm of the flywheel to a corresponding number of collector rings, insulated from each other, fixed on the engine shaft. Thus a current sent in through one of the collector rings to the pointer, passed through one or other of the brass strips (of which there were about thirty), and down to the corresponding collector ring, whence it was conveyed by a brush to the recorder. This consisted of a number of styles made of steel wire corresponding in number to the numbers of brass strips and collector rings, pressing on a sheet of paper damped with a solution of yellow prussiate of potash and ammonium nitrate in water which was drawn across beneath the row of styles by an electromotor. The passage of current through any style, for even the briefest imaginable period, produced a deposit of Prussian blue on the paper; a record was therefore obtained of the position at any instant of the pointer attached to the pendulum of the governor, and therefore of its progressive displacements. The angular motion of the pendulum between its extreme positions was 7·3°; the traces made by two adjacent styles therefore showed a displacement of one-thirtieth of this, or 0·24°. A scale of time was traced simultaneously by means of a seconds pendulum, which at every swing completed a circuit through a globule of mercury and made connection with another style pressing on the same sheet of paper as that on which the "position records" were traced. For shorter periods of time a tuning-fork electrically driven was used to make and break contact. In addition, traces were made of engine revolutions—one long dash at the dead point with nine short dashes between, made by contacts spaced equidistantly round the shaft; and of a signal contact made either by hand or automatically by the act of altering the load on the engine. From the automatic records thus produced, curves were drawn (some of which are reproduced in the paper) showing the motion of the governor under different conditions of steady or varying load, with greater or less inertia of reciprocating parts, &c. The regularity of the curves is proof of the precision of the method, by which the time in which a given change of position occurs can be read to the one-hundredth part of a second. Amongst other results brought out is the fact that the governor was never in a state of relative rest; thus statical friction, at any rate in governors of the type experimented upon, need not be taken into account. The paper concludes with a bibliography of experimental work on engine governors. B. P. S.

Digitized by Google

391. *Steam-Pipe Covering.* **H. G. Stott.** (Elect. World and Engineer, 40. pp. 854–856, Nov. 29, 1902. Abstract of a paper read before the 23rd Convention of the Association of Edison Illuminating Companies, held at The Mount Washington, N.H., September 9, 10, and 11, 1902.)—In order to determine the best means of covering steam pipes for the Manhattan Railway Company's power-house, 200 ft. of 2-in. iron pipe was coupled in series and connected with a 250-kw. dynamo, together with measuring instruments. Lengths of 15 ft. were marked off and fitted with potential wires 2 ft. from each end; these lengths were then covered with various types of covering, the resistance of each section and the temperature coefficient determined, and the whole length of pipe heated by electric current to about 370° F. for three days to dry the coverings. The tests were carried out at various temperatures, the current being kept on for about ten hours before taking readings in order to allow the temperatures to become steady. From the watts lost in each section the rate of loss of heat was calculated; repeated tests agreed within 2 per cent. The accompanying table shows some of the results for a thickness of about 1·125 in.

HEAT SAVED BY COVERING STEAM PIPES.

Covering.	B.Th.U. Lost per sq. ft. at 160 lbs. pr.	Per cent. Heat Saved by Covering.
85 per cent. Magnesia: sectional	2·060	84·2
Solid cork: sectional	2·170	83·3
Laminated asbesto cork: sectional	2·395	81·6
Asbestos air cell [indented]: sectional ["Imperial"]	2·465	81·0
Asbestos sponge felted: sectional.....	2·683	79·4
Asbestos air cell [long]: sectional	3·380	74·0
"Asbestocel" [radial]: sectional	2·920	77·5
Asbestos air cell [long]: sectional	3·015	76·8
"Remanit" [carbonised silk] wrapped.....	1·708	86·9
Bare pipe [from outside tests]	13·000	...

The efficiency of magnesia was found to vary directly as the square root of the thickness. A table is given showing the relative values of the first cost and the heat loss for different thicknesses and various periods, from which it appears that the thickness of covering should be determined with regard to the intended duration of the installation, and is an important consideration.
A. H. A.

392. *Prevention of Smoke.* **J. S. Raworth.** (Electrician, 49. p. 911, Sept. 26, 1902. Abstract of a paper read before Section G of the British Association at Belfast.)—This paper gives the results of evaporative tests of a water-tube boiler at the works of the Electric Traction Company at Kidderminster (*a*) under ordinary conditions, (*b*) with air-blast directed in small jets over the surface of the fire, and (*c*) with the Wilson process. This process consists in forcing jets of air over the surface of the fire, the air carrying with it in the form of spray a solution of nitrate of soda. The air is introduced through cast-iron blocks built into the furnace walls at the four corners, the chemical being sprayed in at the two front corners only. The cost of the nitrate used is from 3d. to 4d. per ton of coal burnt.

Digitized by Google

SUMMARY OF RESULTS OF TESTS ON BOILER AT KIDDERMINSTER.

Date of Test.	May 23. With Air and Chemical.	May 24. With Air only.	May 25. Ordinary Condition.	May 30. With Air and Chemical.
Duration of test	7·08 hours	7 hours	7·42 hours	7 hours
Average pressure of steam	113·3 lbs.	115 lbs.	117·7 lbs.	115·3 lbs.
„ temperature of steam (superheated)	469° F.	473° F.	459° F.	466° F.
Average temp. of steam feed	143° F.	140° F.	146° F.	150° F.
Total coal	2,856 lbs.	3,416 lbs.	3,248 lbs.	2,744 lbs.
„ per hour	403 lbs.	488 lbs.	438 lbs.	392 lbs.
„ „ per sq. ft. of grate	15 lbs.	18 lbs.	16·2 lbs.	14·5 lbs.
Total water	19,520 lbs.	19,485 lbs.	17,680 lbs.	17,886 lbs.
„ per hour	2,755 lbs.	2,784 lbs.	2,384 lbs.	2,555 lbs.
Water evapd. per lb. of coal	6·83	5·7	5·32	6·52
Water evapd. per lb. of coal from and at 212° F.	8·38	7·01	6·5	7·95

F. J. R.

393. *The Briquetting of Fuels.* **R. Schorr.** (Eng. and Mining Journ. 74. pp. 621–622, Nov. 8, 1902.)—In Europe the total output in 1882 of coal briquettes was 8,000,000 tons. It is now estimated at approximately 25,000,000 tons, that of Germany being nearly 9,000,000 tons, or almost 6½ per cent. of all the coal mined in that country.

In the United States the cheapness of coal in certain sections, and the discovery of oil in others where coal is expensive, have hindered the development of the briquette fuel industry. There are, however, briquetting works at Stockton, Cal., belonging to the San Francisco and San Joaquin Coal Co., in which there are two continuous-acting presses used, each capable of turning out about 280 tons of 8-ounce boulets per 24 hours. Another briquetting plant for lignite is under construction at New Dallas, Tex., and farther east are the Chicago Patent Fuel Works making eggets on a small scale. The presses used in these works are those designed by the author, those made by the Chisholm, Boyd & White Co., Chicago, or the White machine made by the Henry S. Mould Co., Pittsburg. The Coufinal type of press is the one most favoured in Germany and France for the manufacture of heavy blocks up to 10 kg. for steam fuel. The English presses of the Middleton, Yeadon and Stevens systems are also extensively used in Europe. Continuous-acting presses such as the Fourquemberg and Evrard are employed for the manufacture of small ball- or egg-shaped briquettes (called boulets, eggets, &c.). In the French Navy 820 kilos of fuel blocks go to the cubic metre of bunker capacity, or about 10 per cent. more than with coal. The dust losses rarely exceed 4 per cent. as against 30 per cent. with Welsh coal and even 50 per cent. in stormy weather. The specific weight of briquettes varies with the material and pressure employed, but is usually the same as that of the fuel of which they are made. The manufactured fuel question may be regarded as settled mechanically but not yet commercially. F. J. R.

394. *Liquid Fuel for Steamships.* **E. L. Orde.** (Inst. Mech. Engin., Proc. 8. pp. 417–428; Discussion, pp. 429–435, July, 1902.)—In this paper the author discusses the chemical and physical characteristics of the liquid

Digitized by Google

hydrocarbons—especially those of the Methane series—and the effects of distillation upon the crude petroleums. His reason for doing so is that the proper use of liquid fuel presents many analogies to the processes of distillation. Before complete combustion can take place the fuel must pass from the liquid to the vapour form, and the aim is to accomplish this with the least expenditure of heat without deposition of solid carbon in the apparatus. Analyses of oils from Borneo, Texas, Caucasus, and Burmah, with their calorific values, and a heat balance-sheet from experimental results with Borneo oil, are given. The author then examines the effect of water, mixed with the oil, upon the combustion, and describes the Körting; the Holden, the Rusden-Eeles, the Orde; and the Dürr burners, as typical specimens of three distinct types of burners. Results obtained in some steamships are quoted. In the discussion, **W. Boyd** said that the Rusden-Eeles burner had been successful in steamers of the Shell line, the only objection being the necessity of having an evaporator to make up loss of steam used in the burner. Separation of water from the oil was easily obtained by settling tanks and heating. **J. P. Bedson** said that a gallon of creosote burned in spray under boilers had been found equal to a ton of slack. The creosote then cost ½d. per gallon and the slack 4s. 6d. per ton. **G. Cawley** remarked that on the Great Eastern Railway it was found economical to use oil as long as its cost was no more than double that of coal. The **Author** in reply, said that ratio had not yet been obtained in ships, but that in them 1 lb. of oil was equal to about 1½ lbs. coal of good quality. An ordinary stokehold crew might be reduced 50 per cent. when oil fuel was used. **C. H. Wingfield** communicated a straight line diagram illustrating the relative proportions of coal and oil required when both were burned together for firing a water-tube boiler. 8 lbs. oil evaporated the same weight of water from and at 212° F. as 5 lbs. coal; 0·8 lbs. of oil required 3·7 lbs. coal and 1·85 lbs. oil required 1·85 lbs. coal. [See Abstract No. 546 (1901).] F. J. R.

REFERENCES.

395. *Improved Coal Calorimeter.* **W. Rosenhain.** (Phil. Mag. 4. pp. 451–458, Oct., 1902.)—This instrument, involving no novelty of principle, is of special design, which allows practically complete combustion of the coal, the oxygen being supplied at low pressure, and the process taking place in full view, so that it can be watched and regulated. R. E. B.

396. *Water-tube Boilers in American Mercantile Marine.* **W. A. Fairburn.** (Eng. News, 48. pp. 446–447, Nov. 27, 1902. The article consists of extracts from a paper read at the 10th general meeting of the Society of Naval Architects and Marine Engineers, held at New York, Nov. 20 and 21, 1902.)

Digitized by Google

INDUSTRIAL ELECTRO-CHEMISTRY AND GENERAL ELECTRICAL ENGINEERING.

397. *Calcium-Carbide Factory at Cordova.* **E. Bignami.** (Écl. Électr. 33. pp. 295–298, Nov. 29, 1902.)—This is an illustrated description of the recently completed factory for calcium-carbide production at Cordova, in the Argentine Republic. Three-phase current is generated at a water-power station on the River Rio Primero, and is transmitted the 32·5 km. to Cordova, at 10,000 volts pressure. Four 250-kw. transformers reduce the pressure to 85 volts, and the 8,000-ampere supply current is then used at this pressure for the carbide furnaces. These furnaces are of the Gin and Leleux type, vertical movable electrodes and resistance heating being employed, and each furnace requires 250 kw. under normal working conditions. Lime is obtained in the neighbourhood of the carbide factory, and the carbon is provided in the form of wood charcoal, obtained by burning the wood known as Quebracho Colorado, in specially designed furnaces. The yield of carbide at the Cordova factory is stated to be 5 kg. per kw. day, and a market for the product is found in Argentina. The railway authorities of the country have already begun to utilise acetylene for lighting some of their trains, the system employed being that of Molet, in which cylinders charged with acetone and acetylene are used for storing the gas. J. B. C. K.

398. *The Harmet Process for the Electrothermic Production of Steel.* **J. Reyval.** (Écl. Électr. 33. pp. 228–231, Nov. 15, 1902.)—This is an illustrated description of the Harmet furnace and process for the manufacture of steel by aid of electric heat [see Abstracts Nos. 1399 and 2297 (1902)]. The author lays emphasis upon the value of the refining or "regulating" portion of the furnace, and states that this offers many advantages over the usual Martin process for the production of special steels. A series of these refining furnaces can be ranged round the reducing furnace in the Harmet plant, and several varieties of steel may therefore be produced at the same time. The figures given by the author for power consumption and cost of the Harmet process are based on the estimates previously published—namely, 3,600 e.h.p. hours and 29·24 francs per ton of steel produced. J. B. C. K.

399. *The Atkins Hypochlorite Cell.* **E. Walker.** (Eng. and Mining Journ. 74. pp. 679–680, Nov. 22, 1902.)—The Atkins cell for the production of hypochlorite of soda solutions by electrolysis of sodium chloride consists of a semicircular wooden trough 10 ft. long by 2 ft. in diameter, lined with lead, and then with carbon blocks hollowed out to fit the curvature of the trough. These blocks are cemented together, and form the anode of the cell, while a wooden cylinder covered with lead is mounted to revolve in the trough, and forms the kathode. A space of 1 in. separates anode and kathode, and this is occupied by a 10 per cent. solution of sodium chloride. The apparatus takes a current of from 1,000 to 1,500 amperes at 3½ to 4 volts, and the flow of solution through the cell varies from 500 to 1,000 gallons per hour, the rate depending upon the degree of concentration required in the solution of hydrochlorite produced. Owing to the large surface presented to the solution, little or no heating of the electrolyte occurs. A firm

Digitized by Google

of linen bleachers in Scotland is now trying the Atkins cell for production of bleaching solutions, and an Australian gold-mining company is considering the possibilities of the cell in connection with a chlorination method of gold extraction. In the latter case, the hypochlorite solution would be treated with sulphuric acid, and the liberated chlorine used for treating the auriferous ore. J. B. C. K.

400. *Electric Furnaces for the Manufacture of Carbon Bisulpide.* **W. Hoskins.** (West. Electn. 31. pp. 287–288, Oct. 25, 1902.)—This is a further description of the Taylor furnaces at Penn Yan, N.Y. (See also Abstract No. 1167 (1902). An improvement on the method originally described consists in using the walls of the conduit, through which the coke is fed into the furnace, as electrodes. The coke falls by gravity through these conduits, and conveys the current from the fixed electrodes on the walls of the conduits to the furnace. A diagram is given showing the improved form of construction. E. R. Taylor read a paper at Niagara Falls on September 17, 1902, describing advances in the closed and continuous-working electric furnace, and a portion of this paper is here quoted. He here points out that for the proper working of his furnace a self-renewing electrode is necessary, and this he effects by making the broken coke in its descent into a kind of moving electrode. New material continually descends to take the place of that exhausted at the ends of points of wear. W. H. S.

401. *High Insulation Switches.* **H. Voigt.** (Elektrotechn. Zeitschr. 23. pp. 939–940, Oct. 23, 1902.)—Two types of construction suitable for switches, wall-sockets, and ceiling-roses are described. In the first, the porcelain block carrying the metal parts is fixed into a metal box with a lining of insulating material by means of pitch or a similar compound, thus avoiding the use of screws. In the second the metallic parts are fixed to a porcelain block which serves at the same time as a cover. A. E. L.

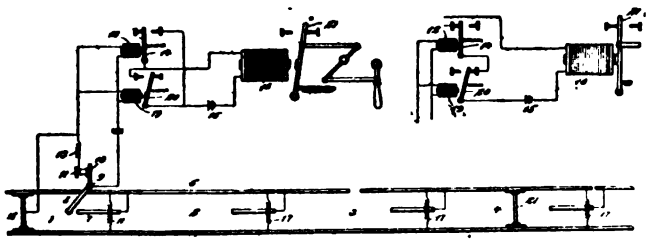
402. *Hydraulic Governor with Relay.* (Eng. News, 48. p. 409, Nov. 13, 1902.)—The Replogle Governor Works of Akron, O., is building a centrifugal governor specially adapted for use on water-power plant where a relay must be employed to work the water-gates. Instead of the rigid link suspension usually employed to connect the governor balls with the sleeve on the shaft, short chains are used and the sleeve is made in one piece with a horizontal fly-wheel. In case of a sudden variation of speed the flywheel does not immediately respond, but swings on the chains, thus raising or lowering the sleeve. The relay consists of a friction clutch of novel construction. A cast-iron sphere is mounted on a shaft which can be moved longitudinally by the governor. Two cup-shaped friction wheels, having a radius of curvature slightly greater than that of the sphere, are pressed against it by springs. They are rotated in opposite directions about a common axis. When the centre of the sphere lies in this axis no motion is transmitted to it, but if it be displaced in either direction it will be rotated at a greater or less velocity according to its displacement. A. E. L.

403. *Dimensions of Contact Surfaces and Binding Screws for Electrical Apparatus.* **R. Hellmund.** (Zeitschr. Elektrotechn., Wien, 20. pp. 497–499, Oct. 12, and pp. 511–515, Oct. 19, 1902.)—Assuming the permissible rise in temperature for switches, starting resistances, regulators, &c., to be 50° C., *i.e.*, from 20° C. to 70° C., the author proceeds to deduce a formula giving

Digitized by Google

the current density (C) in terms of (1) the rise in temp. (T), (2) the surface factor (S), *i.e.*, the ratio of the actual to the specified contact surface, (3) the cooling coefficient (C), and (4) the contact resistance per sq. mm. (R). The relation $C = \sqrt{TSC/R}$ holds in most cases. The minimum values of S, C, R are 0·05, 0·00006, and 0·07 respectively, giving for $R = 50°$ a current density of 0·046 ampere per sq. mm. The maximum values of the same quantities are 0·95, 0·004, and 0·0045 respectively, giving a current density of 6·5 amperes per sq. mm. In calculating the current density for various types of switches, the author distinguishes between those which are new and those which give sparking contact, as the latter will require about one-half the density of the former. For a radial type of switch (single pole) $C = 1·48$ amperes per sq. mm.; ditto (double pole) $C = 2·0$; for a chopper pattern $C = 0·505$. In the case of bolts and screws the rise in temperature depends on the main current (A) and the diameter (d): the rise in temperature $T = kA^2/d^4$, where k is a constant depending on the special kind of bolt or screw in use. A table is given showing the diameter of bolts (in English measurement) necessary to carry various currents and allow for a rise of 50° C. above the air temperature: *e.g.*, a 1-in. bolt will carry 400 to 700 amperes, a 1½-in. bolt 900 to 1,600, a 2-in. bolt 1,600 to 2,800; the limit values, corresponding to two definite methods of fixing the bolts. E. S. A. R.

404. *Automatic Controller for Steam Locomotives.* (Scientific American, 87. p. 308, Nov. 8, 1902.)—A device is described for automatically shutting off steam and applying the air brakes, in cases where signals are against a train, or where a car happens accidentally to be on the track ahead. It is due to the Automatic Train Controller Company of 25, Broad Street, New York. The apparatus is in the engine cab, and the mode of working can be seen from the diagram. The block sections are shown as rails 5 discontinuous,



the other rails being continuous. At the end of each block is a contact rail 7. A contact lever 8 from the locomotive touches rail 7 as it passes over, and contact 10 is thus pulled open.

If a rail should be removed in the section in front, or should a drawbridge be open, Magnet 12 would release its connection, Magnet 16 would come into action, and its armature 21, through lever and link connections, would shut off steam and apply brakes. If a pair of wheels is on the section ahead, resistance 17 is short-circuited, the local current becomes strong enough to pull over the armature of Magnet 19, and the train is stopped in the same way as before. Should the battery fail or connections become broken the same action occurs. E. O. W.

405. *Electrical Lifting Machinery and Conveyors.* **Kammerer.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1377–1384, Sept. 13; and pp. 1421–1429, Sept. 20, 1902. Paper read before the 43rd meeting of the Association of German

Digitized by Google

Engineers at Düsseldorf.)—The author considers the various types of electrical machinery used for the transportation of loads, including lifts, cranes, transporters, telpherage, &c. In particular he considers the question of starting such machines, which he illustrates by several graphic diagrams, and also the various points in which the application of electrical methods has affected general matters of design. [See also Abstracts Nos. 47 and 267 (1903).] W. H. S.

406. *Pumping Plant for Condensing Water.* **C. Hopkinson.** (Inst. Mech. Engin., Proc. 8. pp. 487–489; Discussion, pp. 464–481, July, 1902.)—This paper is a description of a system in use at the Newcastle Tramway Power Station, consisting of pumps, water-turbines, and electromotors, one of each being coupled direct on one shaft, the discharge water working the turbines, and the losses in the system being supplied by the electromotors. The water is pumped from the Tyne, 500 yards away, and 86 ft. below the level of the engine-house. The pumps are of Mather & Platt's single chamber high lift centrifugal pattern, with wheels 23⅝ in. diameter; the water enters the pump axially, symmetrically on each side, and issues tangentially. The construction of the turbines is exactly the converse of this, the water entering tangentially and leaving axially. The turbine wheels are 18¼ in. diameter. Two sets are already installed, and arrangements are made for a third; the present capacity is 75,000 gallons per hour, but the full plant is intended eventually to have a capacity of 150,000 to 200,000 gallons. Tables are given of levels, results of tests, &c., and the paper is illustrated by curves and diagrams showing the general arrangement of the plant. [See also Abstract No. 991 (1902).] B. P. S.

407. *Mechanical Appliances in Mines (Coal-cutting and drilling).* **R. H. Wainford.** (Inst. Mech. Engin., Proc. 8. pp. 545–564; Discussion, pp. 564–578, July, 1902.)—This paper summarises the advantages of mechanical means for cutting coal, and drilling for blasting. Figures are given in some detail as to the saving in cost, and the increased value in large coal of the product. The capital outlay is covered, to some extent, by the reduced number of miners' cottages necessary. The general conclusion is that from 6d. to 1s. per ton may be saved by mechanical appliances. The bar cutter of Hurd, and the disc type of Clarke Stephenson and the Diamond Co. are illustrated, as also the Rock drills of Frölich & Elliott. LL. B. A.

408. *Fischer's Magneta System of Synchronised Electric Clocks.* **A. Lambot.** (Soc. Belge Élect., Bull. 19. pp. 647–654; Discussion, p. 654, Nov., 1902.)—In this system, the master clock causes a prism of iron arranged between the poles of a permanent magnet to oscillate every minute through an angle of 90° in the interior of a coil of wire, so as to send currents into the line which are first in one direction and then in the other. The secondary clocks each comprise a clockwork-train driven by means of a star-wheel coacting with an oscillating fork or pallet. This fork bears a transversely arranged armature, which is polarised by being arranged near one pole of a permanent magnet, and has its ends opposite the poles of a horse-shoe electromagnet, the coils of which are connected with the line wires. By this means the armature will be oscillated by the successively reversed currents in the line. Moreover, the circuit is always closed, so that no batteries are required, and no make and break contacts are employed. The apparatus is constructed by La Société Magneta, of Zurich, and a number of installations are already in successful operation. C. K. F

Digitized by Google

409. *Pfatischer's Electric Steering Gear.* (Elect. World and Engineer, 40. pp. 845–847, Nov. 29, 1902.)—In this arrangement, a small current is passed through two exactly equal resistances connected in parallel, one of them being arranged at the steering station, and the other near the rudder. Over these resistances move contact-arms operated respectively by a hand-wheel and gears and by the rudder, the said contact-arms being connected by a balance-wire, which includes the field of a small, continuously driven exciter dynamo. The exciter armature is connected to the field of the main generator which is continuously driven, and which has its armature connected to the armature of the separately excited rudder-motor. When the contact-arms are at corresponding points on the two resistances, there is no current in the balance-wire, the exciter, and, therefore, also the main generator, are not excited, and no current flows in the armature of the rudder-motor. If, however, the contact-arm at the steering-point is moved, a difference of potential is produced between the ends of the balance-wire, the exciter, and, therefore, also the main generator, are excited, so that a current flows into the armature of the rudder-motor, the direction and magnitude of this current depending on the direction and magnitude of the displacement of the contact-arm at the steering-point from the point corresponding to that of the contact-arm at the rudder. The motion of the rudder so produced is in such a direction as to bring the contact-arm at the rudder into a position corresponding to that of the contact-arm at the steering-point; when this position is reached, the current in the balance-wire is again zero, and the motion of the rudder-motor ceases. In the Red Star liner *Finland*, the rudder-motor is of 60 h.p. and 100 volts; the main generator is 60 kw. at 110 volts, and a 4·5-kw. shunt-wound generator of 110 volts serves for supplying current for the rheostats and the rudder-motor field. Or this shunt generator can be supplied with current from the ship's lighting circuit so as to run as a motor and drive the exciter. The connections are fully described, and photographs given of the apparatus in use. C. K. F.

410. *The Méray–Rozar Electric Type-forming and Justifying Apparatus.* **J. Reyval.** (Écl. Électr. 33. pp. 78–82, Oct. 18, 1902. See also Bulletin de la Société des Ingénieurs Civils, Aug., 1902.)—This apparatus comprises two machines, viz.: (1) a keyboard machine for perforating a continuous strip of paper in accordance with the characters to be formed, and (2) a machine which, controlled by the said perforated strip, casts the type and the justifying spaces. In the first machine, the perforator is combined with a typewriter whereby a record is obtained of the keys struck, and with a calculating apparatus which registers the thickness of the corresponding characters with provisional spaces of a standard width, the dimensions of the letters and of the spaces being added up as each line is written. At the end of the line the apparatus calculates the difference between the total reached and the predetermined length of line, divides this difference by the number of spaces and writes on the correcting band the correction for each space, these three operations taking place automatically on operating the justification lever. The corrections can be positive or negative reckoning from the normal value. The band passes into the machine for casting the type, in the reverse direction to that of the writing, so that before commencing a line this machine will have noted the value of the spaces to be supplied. In the machine for casting the type, the molten metal is injected by a piston into a mould of which one end is closed by a hollow matrix forming the printing face of the character. These matrices are grouped in threes on the three

Digitized by Google

facets of 29 blocks contained in a movable carriage which executes a reciprocating motion for each character cast. At each reciprocation the carriage delivers one of its facetted blocks in front of the mould; this block remains there for $\frac{1}{10}$ of a second to receive the jet of metal, and then resumes its place in the carriage. The selection of the blocks is effected by an apparatus controlled by the perforations in the band and of analogous construction to that of the "combinateur" of the Baudot telegraph. The mould is formed by a rectangular chamber of which one wall is closed by a movable slide which advances more or less to obtain characters of various thicknesses, this advance being controlled by a lateral rod abutting against gauge blocks in the blocks carrying the matrices. The spaces are cast like the characters, but in this case the mould is closed by a plain block, their thickness being determined by a screw fixed in a lug on the movable slide of the mould, this screw abutting against one end of four discs arranged coaxially, one pair having stepped coacting ramps and the other pair helicoid coacting ramps. The holes in the paper strip are formed along eight longitudinal lines, each of one series of transverse lines corresponding to one character. The zero longitudinal line serves for driving the strip, whilst the combinations of the holes in lines 1, 2, 3, 4, 5, serve to designate the different blocks carrying the matrices, and the holes in lines 6 and 7 serve for rotating the said blocks through angles of 45° in case one of the lateral matrices is to be applied to the mould. At the end of the first series of transverse lines two transverse rows are reserved for justifying; in this case, the holes to signify subtraction and hole 7 addition. One of these transverse rows indicates, by adding the perforations from 1 to 5, the number of tenths of millimetres which forms the positive or negative correction for all the spaces of the line, this row corresponding to the helicoidally ramped discs above mentioned. Of the other transverse row, only one perforation is made, this single perforation indicating the number of the first spaces of the line which should receive a + correction of $\frac{1}{10}$ mm., this correction being cancelled after the ninth space; this transverse row corresponds to the stepped discs above mentioned. The electrical part of the apparatus comprises 15 electromagnets of 100 ohms, each supplied with current at 10 volts, only one of them being in action at a time. The band passes over a drum having a ring of teeth to engage with the driving perforations of the zero longitudinal line. The other seven longitudinal lines coact with levers which, when they are pulled by a spring into the perforations, act on ivory pins whereby spring contact-pieces are moved against other contact-pieces. Each of these pairs of contact-pieces is included in a branch circuit from the + pole of the electric generator, and each of these circuits is interrupted at a pair of contact-pieces arranged along concentric circles around which moves a rotary bridge-piece which, in order that only one electromagnet shall be in circuit at a time, successively completes the whole of these circuits during about $\frac{2}{3}$ of each revolution, corresponding, for example, to the casting of one character or space. By means of a seven-armed switch these circuits can be brought into communication with a series of electromagnets controlling the character-moulds, or with electromagnets controlling one of the stepped discs above mentioned, or with electromagnets controlling one of the helicoidal discs. The machine also comprises a stop-motion which stops it on any irregularity of action taking place. Some illustrations and a diagram of connections are given in the original. C. K. F.

Digitized by Google

GENERATORS, MOTORS, AND TRANSFORMERS.

411. *Methods of Compounding Continuous-Current Dynamos for Variable Speed.* **F. Loppé.** (Écl. Électr. 38. pp. 181–187, Nov. 8, 1902.)—The author describes a method of winding to give constant volts with variable speed, suitable for train-lighting and such work. The field is wound with two circuits; one is a shunt, the other is separately excited by a battery or motor generator, and the two are opposed to one another. Either the shunt or the separately excited circuit may be made the strongest, but as the ampere-turns in the two circuits should be nearly equal for good regulation, a large amount of copper is required. R. B. R.

412. *Theory of Commutation.* **A. Rothert.** (Elektrotechn. Zeitschr. 23. pp. 865–868, Sept. 25, and pp. 884–890, Oct. 2, 1902. See also Elect. Engin., Nov. 14, 1902.)—Assuming that the brush covers a single segment, the author establishes the differential equation—

$$L\frac{di}{dt} + i(r_1 + r_2 + r_3) - I(r_1 - r_2) = 0,$$

in which L and r_3 stand for the inductance and resistance of the coil, r_1 and r_2 for the brush contact resistances (these will be functions of t), i for the instantaneous current in the short-circuited coil, I for the original current in coil at commencement of short-circuit. In most cases, r_3 may be neglected in comparison with r_1 and r_2. The author finds the solution of this equation for various special cases by a purely graphical method, and draws curves showing the variations in the current, the sparking voltage and the reactance voltage during the period of commutation. He investigates the case in which high-resistance connectors are employed, and finds that the use of such connectors is not always productive of better commutation (what is wanted is a large *change* of resistance, and not a large permanent resistance in the circuit of the short-circuited coil). Another case investigated is that of a compound brush whose forward part is more highly conducting than its backward part; the curves showing in this case a marked improvement in the commutation. A. H.

413. *Sparkless Commutation.* **J. Freund.** (Elektrotechn. Zeitschr. 23. pp. 931–932, Oct. 16, 1902.)—Referring to Rothert's paper on this subject [see preceding Abstract], the writer shows, by a purely analytical method applied to a modified form of the equation given by Rothert, that the condition for sparkless running is $RT/L > 1$, where R and L stand for the resistance and inductance respectively of the short-circuited coil, and T is the duration of the short circuit. A. H.

414. *Commutators and Slip-rings.* **R. Hellmund.** (Elektrotechn. Zeitschr. 23. pp. 824–827, Sept. 11, 1902.)—This is a discussion of the best treatment of commutators and slip-rings for metallic and carbon brushes. Curves are given showing the results of experiments on the effect of lubrication on the contact resistance of brushes. These show that with copper or brass gauze brushes the resistance is appreciably reduced by the use of ordinary dynamo oil if the commutator be smooth and bright. With a rough surface, however,

Digitized by Google

the difference is less in the case of brass brushes, while with copper gauze brushes the effect of oil is to increase the contact resistance. Special commutator lubricants usually increase the contact resistance with a view to securing better commutation [see also Abstract No. 1746 (1900)].

A. E. L.

415. *Voltage Drop in Alternators.* **F. Kesselring.** (Elektrotechn. Zeitschr. 28. pp. 890–891, Oct. 2, 1902.)—The reluctance of the path followed by the magnetic flux produced by the component of the armature current which is in phase with the e.m.f. is practically unaffected by saturation of the iron, whereas that of the flux due to a current in quadrature with the e.m.f., depends very largely on the saturation of the field cores and yokes. This consideration leads the author to consider separately the effects due to the two components of armature current. If the reluctance of the field-magnets were constant, the open-circuit characteristic OP_0P (Fig. 1) would be a straight line OR_0R tangential to the initial portion of the actual characteristic. Further, since the e.m.f. is proportional to the ampere-turns required for maintaining the air-gap flux, PR may, to a certain scale, be taken as repre-

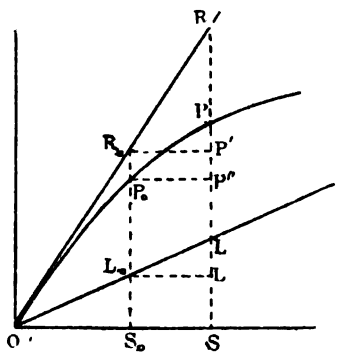


FIG. 1.

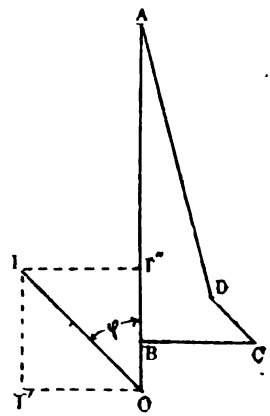


FIG. 2.

senting the ampere-turns used in the iron part of the circuit. If the field ampere-turns change from OS to OS_0, the total change in the ampere-turns is, to a suitable scale, represented by RP', the change in the air-gap ampere-turns by PP'', and the change in the iron ampere-turns by RP' — PP''. In order to obtain the p.d. corresponding to any given armature current, we draw OA (Fig. 2) to represent the e.m.f. corresponding to the given constant exciting current (OA = SR in Fig. 1), and draw the vector OI to represent the + armature current, ϕ being the lag of this current behind the e.m.f. The current is resolved into the components OI' and OI'', in quadrature and in phase respectively with the e.m.f. The component OI' (Fig. 2), represented by LL' in Fig. 1, where OL is the short-circuit characteristic, reduces the ampere-turns by an amount $L_0L' = S_0S'$, and the e.m.f. by a corresponding amount PP'' (Fig. 1). In Fig. 2, lay off OB = PP''. Let next in Fig. 1 LL' be made equal to OI'', and let in Fig. 2 BC be drawn at right angles to AB, BC being made equal to the length RP' in Fig. 1 when LL' = OI''. Lastly, let CD be drawn parallel to OI to represent the resistance drop in the armature. Then AD gives the p.d.

A. H.

Digitized by Google

416. *Flywheel capacity of Engine-Driven Alternators.* **W. I. Slichter.** (Amer. Soc. Mech. Engin., Trans. 24. No. 0967. pp. 1–18, 1902.)—In this paper the author classifies and discusses the causes of cyclical speed variation of engines, and gives as an approximate formula for the displacement of the crank-pin from the mean position the equation $A = \frac{k \times P \times g \times 360}{WV_0^2 \times 4\pi n}$ where k is the "unbalancing factor," or the ratio of the maximum unbalanced energy (which goes to accelerate the flywheel) to P, the total foot pounds of energy per revolution, W is the effective weight and V_0 the mean speed of flywheel, g the gravity constant 32, and n the number of impulses per revolution. The value of k may be from 0·15 to 0·30. For flywheel alternators the value of A must be multiplied by the number of pairs of poles to give the displacement from the mean in the electrical circuit. The maximum allowable value for this quantity is about 2·5, if the maximum cross current is to be limited to 10 per cent. of full-load current; with a greater displacement parallel running, while it might be quite possible under favourable conditions, such as low resistance between generators and few synchronous motors in circuit, would be difficult or impossible under more exacting conditions. The "synchronising torque" of the generators is proportional to the displacement (in alternating plants), and occurs simultaneously with, and increases the effect of, the excess effort of the engine. (In direct-current plants the curve of torque, which is proportional in this case to speed, and not to displacement, is shifted 90° from the curve of engine effort, which it merely distorts.) The formula proposed by the author for determining the effective flywheel weight based upon a maximum displacement of 2·5 is $Wr^2 = 10^9 . KW . C/S^4$ where W is the weight required, r the radius of gyration, KW the rating of the generator, S the number of r.p.m., and C a constant directly proportional to the periodicity and having for 50 periods the values 680, 550, and 500 for horizontal single crank, vertical compound, and horizontal compound engines respectively. The weights calculated by this formula are found to give reasonable values, so far as hunting and parallel operation are concerned, though it may be sometimes necessary for special reasons, *e.g.*, in railway power stations, to increase the weight immensely, and to ignore the angular displacement. Lastly, the question of hunting is referred to, and the remedies are pointed out —dash-pot governors or "amortisseurs." The paper is illustrated with curves showing the actual performance of an 800-kw. compound engine and alternator set; a noticeable feature being the combined curve of high- and low-pressure crank efforts which shows practically only two impulses per revolution. B. P. S.

417. *Notes on Alternator Design.* **J. Denham.** (Electrician, 49. pp. 903–907, Sept. 26, 1902. Paper read before the Cape Town Local Section, Inst. El. Eng. April 28, 1902.)—The author discusses types which he classifies as (1) those in which the magnetic flux through the armature varies in direction; (2) those in which the magnetic flux is constant in direction but varies in intensity. Machines of type (2) (Mordey, Ferranti, and Siemens) have a lower output per unit of weight than those of type (1), as half of the windings are necessarily idle at any given moment and merely act as series resistances. Although self-induction of the windings conduces to drop of voltage, a certain amount is advantageous as a protection to the machine; and the author cites the case of a machine which was paralleled when out of phase and yet pulled into phase without being damaged. With a standard armature core, the author states that when wound for two-phase the output is double

Digitized by Google

what it would be if wound single-phase. There appears to be no doubt that the greatest output per unit weight can be obtained from a two-phase machine with external-fixed ring armature and internal revolving-alternate poles, while the same machine may, with 30 per cent. more field magnets, be connected for a three-phase system with approximately the same output and an increased $\sim$, and incidentally, an increase of magnetic leakage. With the same pole-pitch, &c., and the same diameter, as measured at the air-gap, an internal arrangement of fields is the most economical in material, and this is now practically the general practice in alternator design; but for direct-current machines the necessity of adjusting the brushes requires them to be stationary, which is best attained by having external fields and an internal revolving armature. R. C. R.

418. *Stanley-Kelly Alternate-current Generator.* (West. Electn. 31. pp. 345–346, Nov. 15, 1902.)—In this generator the field is excited by means of a multiphase current from a small alternate-current exciter of low frequency—say about 4. The frequency of the current produced by the generator will be the sum of this frequency and that due to its rotation. It is claimed that by this method the armature reaction, whether with leading or lagging currents, will be automatically compensated by the greater or less flow of current in the exciting windings. The article consists of an extract from the patent specification and is illustrated with the patent drawings. A. E. L.

419. *Asynchronous Polyphase Generator.* **L. Gratzmuller.** (Ind. Élect. 11. pp. 437–439, Oct. 10, 1902.)—The author employs a new principle for making an alternator self-exciting. When we have a direct-current ring-wound armature rotating in a bipolar field, if we make the brushes rotate in the opposite direction to the armature, then if they be connected by choking coils the armature reaction of the alternating currents generated will have a component in the direction of the resultant magnetic flux. Consider now an induction motor having its stator wound for polyphase currents. Replace the rotor by a continuous-current armature having as many brushes on the commutator as there are phases in the stator. Then if these brushes are connected star or mesh fashion by choking coils, we can by driving the rotor make the machine into a self-exciting alternator, the principle used being that given above. The author has verified that a machine made in this way is self-exciting. A. R.

420. *Apparatus for Subdividing Alternating P.D.'s.* **C. Heinke.** (Elektrotechn. Zeitschr. 23. pp. 891–892, Oct. 2, 1902.)—The author describes a transformer of special design fitted with a multiple plug switch which allows of the use of alternating p.d.'s increasing by equal increments, and which may also be applied to other testing and standardising purposes. A. H.

421. *New Rotary Converter Distribution.* (West. Electn. 31. pp. 290–291, Oct. 25, 1902.)—The paper describes a system devised by C. P. Steinmetz and L. R. Emmet, the general connections of which are shown in Fig. 1. The secondaries of the two transformers, T_1 and T_2, are suitably interconnected, and their windings so proportioned that two two-phase systems are produced, the vector diagram for one being T and for the other $\perp$. Fig. 2 is a vector diagram showing how these two systems are combined to form a

Digitized by Google

six-phase source of potential, suitable for feeding a rotary converter. The arrangement may be extended to converters having a number of phases represented by a multiple of 8. The neutral point N (terminals 14 and 15, Fig. 1) gives a convenient neutral connection for a three-wire direct-current supply from the rotary. As difficulty may be experienced in connecting

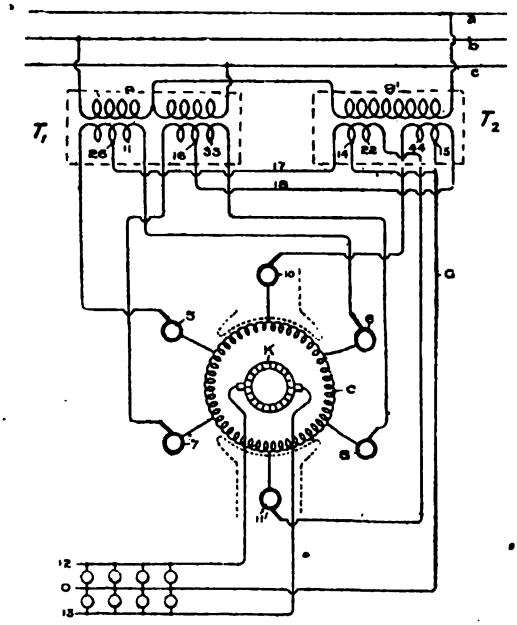


Fig. 1. NEW ROTARY-CONVERTER DISTRIBUTION SYSTEM.

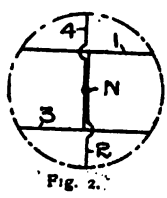


Fig. 2.

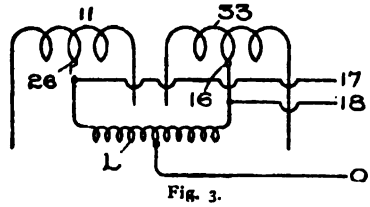


Fig. 3.

straight on to such points in the windings as 14 and 15, the authors suggest a subsidiary device, which is diagrammatically depicted in Fig. 8. [The transformer connections are similar to those employed by Scott for the conversion of two-phase to three-phase current, and the neutral connection has some similarity to the three-wire direct-current compensator of Dobrowolski.]

R. C. R.

REFERENCE.

422. *Calculation of the Voltage Drop of Alternating-Current Generators.* **V. D. Moody.** (Elect. World and Engineer, 40. pp. 619–620, Oct. 18, 1902.)—The method of calculating the voltage drop of alternating-current generators from the magnetising curve at no load and the short-circuit curve is fully explained, and it is applied to find the regulation of a 600-volt, 145-ampere, three-phase generator. Useful hints are given for the commercial testing of alternators with the minimum consumption of power. A. R.

Digitized by Google

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

423. *Measurement of Insulation Resistance of Networks during Working.* **T. Bruger.** (Elektrotechn. Zeitschr. 28. pp. 901–902, Oct. 9, 1902.)—The insulation resistance of each conductor of a 2-wire network may be measured as follows: The positive terminal of a small auxiliary battery of secondary cells is connected to the negative main, the negative terminal being joined to earth through a variable resistance r. A galvanometer is connected between the negative main and earth, and the resistance r is adjusted until the galvanometer shows no deflection. If E = p.d. across mains, e = e.m.f. of auxiliary battery, then the insulation resistance of the *positive* main is given by $\frac{E}{e}.r$. Similarly the resistance of the negative main may be found. The author extends the method to the determination of the total insulation resistance of a multiple-wire network. A. H.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

424. *Newcastle and District Electric Lighting Company's Power Stations.* **W. D. Hunter.** (Inst. Mech. Engin., Proc. 3. pp. 441–451; Discussion, pp. 464–481, July, 1902.)—The Forth Banks Works of this company were originally equipped with three Lancashire boilers 30 ft. by 7 ft. 6 in., and four Parsons single-phase turbo-electric generators of 75 kw. each. Two years ago two 400-kw. direct-current turbo-electric generators were added, and the total capacity is now 3,000 kw. There are two sets of condenser plant, one for surface condensation, dealing with light loads and the other for jet condensation, capable of condensing 48,000 lbs. of steam per hour. The latter was specially designed to take advantage of the position in relation to the river Tyne; the vacuum obtained is generally within an inch of the readings of a standard barometer. The Close Works now in course of construction will have a capacity of 12,000 kw. The five boilers at present erected by the Stirling Boiler Company are described in detail and illustrated. Each is capable of evaporating 18,000 lbs. of water per hour at 250 lbs. pressure per sq. in. The generators, at present two in number, are direct-current turbo-electric sets, each of 1,000 kw. capacity at 500 volts, running at about 1,800 r.p.m. Each generator is really two 500-kw. generators arranged in tandem on the same shaft; one may if necessary be run independently of the other. The turbines are of the latest design and expand the steam from boiler pressure to that corresponding to within 1 in. of the barometer. By means of a solenoid in the main circuit, which acts on the steam valves, the voltage is automatically maintained within 2 per cent. of the normal. The brush rocking gear is controlled directly from the steam cylinder, the effect of any change of load being automatically to place the brushes in the best working position for the new load. A table of engine tests is given, showing results obtained with one of the sets when running at about 10 per cent. below full load; at full load, with a 27 in. vacuum and 24° F. superheat, the consumption

Digitized by Google

of water would be about 17·0 lbs. per kw. hour. The boiler feed-pumps are of Messrs. G. & J. Weir's standard type. The coal-conveying plant to be used has not been definitely decided upon; four alternative designs which have been submitted are described and illustrated. The overhead electrical travelling crane is of the three-motor type by Vaughan & Son. It hoists 15 tons at 4 ft., 7½ tons at 8 ft., 2 tons at 80 ft. per minute. The longitudinal travel is at the rate of 200 ft. and the cross transverse 100 ft. per minute, both at light load. There is an automatic device to prevent overwinding. The efficiency, including all mechanical losses, is about 50 per cent. The condensers and pumps are by Messrs. John Abbot & Co. Each of the condensers has a cooling surface of 8,000 sq. ft. The switchboard is by Messrs. Ferranti, of the cellular type. It comprises six dynamo panels, each designed for 1,000 amperes, and including a voltmeter, an ammeter, two single-pole switches with reverse-current automatic devices, and section of regulating table with hand-wheel. A 6,000 ampere wattmeter is fixed in the centre of the board between the bus-bars to register the total output of the dynamos. There is also an earth-recording ammeter with cut-outs and a mid-wire ammeter. Provision is made for two balancers complete with main switches, ammeters, and starting resistances; and finally there are six three-wire feeder panels, each designed for 1,000 amperes, and comprising two voltmeters, two ammeters, two switches, and maximum-current automatic devices with time-limit relay. The paper is well illustrated by photo-blocks and plates. B. P. S.

425. *Electric Power Station at Neptune Bank, Newcastle-upon-Tyne.* **W. B. Woodhouse.** (Inst. Mech. Engin., Proc. 3. pp. 453–463; Discussion, pp. 464–481, July, 1902.)—The paper contains a description of this station [See Abstract No. 1821 (1901)], and tests of the steam consumption of the turbo-alternator and of a 1,400 i.h.p. triple-expansion three-crank engine, by the Wallsend Slipway Engineering Co., forming a portion of one of the 700-kw. units. The results obtained for the former are 18 lbs. of steam per kw.-hour, and for the latter, under a load of 719 kw., 17·09 lbs. per kw.-hour. The paper, which is illustrated by plates and diagrams, concludes with a summary of the considerations which govern the design of engines driving alternators in parallel. B. P. S.

426. *Sub-Station of the Chicago Edison Company.* (Elect. World and Engineer, 40. pp. 849–853, Nov. 29, 1902.)—In this paper the plant and arrangement of Randolph Street Substation of the Chicago Edison Company are described. It has been recognised that in this part of Chicago the limit of direct-current transmission has been reached, even with a power station comparatively near the load centre of a congested district, and the system considered standard when the station was planned ten years ago has, therefore, been abandoned in favour of rotary converter substations. The Randolph Street Substation is in the basement of a 21-storey fire-proof office building and is laid out for twelve 270-volt rotary converters, each of 500 kw. capacity, of which five are already installed. Each has a bank of three transformers mounted in sets of six over air chambers and cooled by centrifugal blowers. The primary voltage on the transformers is 9,000 and the range afforded is from 240 to 270 on the direct-current bus-bars. The regulators are adjustable either by hand or by small induction motors to minimise the risk of breakdown. Three sets of three-phase mains enter the station at different places, coming from the same or different generators in the power

Digitized by Google

station by different routes. Each set of mains is connected by oil switches to bus-bars supplying, also through oil switches, the primaries of transformers of four of the rotaries; if necessary, the various bus-bars can be coupled in parallel. The direct-current leads from the rotaries to the switchboards are also isolated as much as possible so that a short circuit in one of the trenches in which they are run could not cripple more than two converters. A full description is given of the twelve switchboard panels, one for each rotary, which contain both high- and low-tension control switches. Red and green pilot lamps show whether the switches are open or closed; the high-tension switches have overload tripping relays. A Lincoln synchroniser is used for paralleling the rotaries. Any want of balance of the load on the two sides of the system is at present adjusted at the generating station, but a 100-kw. 125-volt rotary is provided to be used in future on either side of the system as required. By means of a relay worked by a contact on the pointer of a central zero ammeter in the leads from the direct-current bus-bars to the converters, a circuit breaker is operated when a current in excess of 500 amperes flows from the machine; in starting, however, the position of the fixed contact is such that the use of 1,000 amperes in the reverse direction is allowed. The direct-current ammeters are not provided with the usual cumbersome shunt resistances, but current for them is tapped off from two points on the cable at a suitable distance apart. Compensation for temperature error is made by a coil of fine copper wire surrounding the cable and put in series with the ammeter. The marble slabs of which the switchboards are made are not mounted directly on the angle iron frames, but are separated from the latter by insulating distance-pieces 3½ in. thick. This permits of the circuits being run much more neatly and safely than if they had to be carried over the iron frame. The substation is ventilated by fan-blowers. As the Chicago Edison Company is constantly increasing the number of its substations (the growth for the current year being about 49 per cent.), and as the Harrison Street generating station is now full, a new power station of 100,000 kw. capacity is being put down. The supply will be 25-cycle, three-phase, 9,000-volt current for transmission to substations, which will transform, some of them to direct current as described above, and others to 60-cycle, 4,000-volt, three-phase, so as to work in with the supply given by the Commonwealth Electric Company. [See also Abstract No. 989 (1902).]

B. P. S.

427. *Cleckheaton Electricity Works.* (Elect. Engin. 30. pp. 762–766, Nov. 28, 1902.)—The two boilers at present installed are of the Lancashire type, with Meldrum furnaces for burning refuse with forced draught; two more are to be put down, for burning coal. There is a Green economiser of 192 tubes, with motor-driven scrapers, a jet condenser by Alley and MacLellan, two 1,000-gallon feed pumps and a 4,000-gallon supply pump, all driven by motors. The generating plant consists of three Holmes dynamos of 150 kw. capacity each, coupled direct to Belliss engines. The dynamos are compound-wound to give 550 volts for traction, but are shunt-wound for lighting supply. There is also a Phœnix booster of 7 kw. The switchboard carries positive and negative lighting, traction and battery bus-bars, and a mid-wire bar, and each dynamo is provided with two three-way switches for connecting with any of these. The battery comprises 270 cells of the E.P.S. type, giving 500 ampere-hours at 50 amperes. The cables are of the triple-concentric paper-insulated lead-covered type made by the B. I. W. Co., and are laid throughout on the solid system. The prices charged are 5d. per unit for lighting and 2d.

Digitized by Google

for power to ordinary consumers; energy is also supplied to a tramway company at 1·5d. per unit for a minimum of 400,000 units per annum, 1·4d. for the next 100,000 units, and 1·3d. for all above 500,000 units. A. H. A.

428. *Electric Installation of the "Société Hydro-Électrique de Fure et Morge."* (Ind. Élect. 11. pp. 487–498, Nov. 10, 1902.)—The undertaking described is the water-power electric installation erected by the "Société Hydro-électrique de Fure et Morge," 15 km. distant from Grenoble, deriving motive power from the river Drac and supplying electric energy to the industrial valleys of the Fure and the Morge, from which the Society takes its name. The hydraulic works are for the most part of the general type. The conduit leading to the turbines is 4,600 m. long, the first part (2,100 m.) being of armoured cement and the remainder (2,500 m.) of sheet steel. The whole conduit rests on a concrete foundation, 30 cm. thick under the armoured-cement pipe and 50 cm. thick under the steel pipe, and all buried in the ground. By this method of resting the metal conduit of large diameter (330 cm.) upon a cradle of cement buried in the ground—a method adopted here for the first time—the great advantage is gained of preventing deformation of the pipe during the delicate operation of filling, and excellent results have been obtained. This conduit is supplied with three stacks at intervals along its length, two of armoured cement and one at the very end of sheet steel, which, by providing an outlet, prevent the battering action of the water in the event of a sudden stop of the turbines. The head of water obtained, allowing for losses in the pipes, is 32 m., and as the amount used is 17 cub. m. per second, the hydraulic power in the hood of the turbines is 7,200 h.p. In the power-house the generating sets are in a hall 44 m. long and 12 m. broad, with a 15-ton overhead crane. Directly underneath the floor of this hall is a gallery containing the cables from the generators to the switchboard. There are in the main hall five turbines, each of 1,350 h.p., connected to alternators; two turbines, each of 150 h.p., for the exciting generators; and one 5-h.p. turbine which feeds the hydraulic accumulators necessary for the operation of small pilot-motors provided for actuating the sluice-valves controlling the water supply to each of three of the main turbines. Each turbine is directly coupled to a Brown-Boveri three-phase alternator, generating current at 3,000 volts at 3,000 r.p.m. with a frequency of 50 periods per second. The output of each alternator on an inductive circuit of power-factor 0·8 is 950 kw. Each generator can supply 225 amperes per phase with power-factor 0·8, and 180 amperes with power-factor 1. The exciting generators are of capacity 100 kw. and supply continuous current at 110 volts. One is held as reserve, while the other excites the field windings of the alternators and supplies energy for the lighting of the buildings. The voltage of the alternators is transformed to 26,000 volts by step-up oil-cooled transformers placed in another room in the basement. They are so designed that by a simple change of connections the transformation may be made either from 3,000 to 15,000 volts, or from 3,000 to 26,000. The primary has a mesh-winding; the secondary may be connected either in mesh or in star according as the line voltage desired is 15,000 or 25,000. On a balcony overlooking the generators is placed the switchboard, which receives only low-tension currents, but from it the switches for the 3,000-volt lines, which are placed in an enclosed space under the balcony, can be operated by chain-gearing. The switches and fuses and all other apparatus bearing the line voltage are placed behind this main switchboard, where are also found the lightning arresters for the protection

Digitized by Google

of the line. The transmission is by overhead wires extending to various towns in the district. The principal centres are Moirans, Voiron, Rives, Charavines, Fures-Tullins. Moirans, to which the lines are first led, is about 35 km. distant from the generating station. The voltage chosen—26,000 volts—is the highest actually in use in Europe. 3,500 kw. are transmitted to Moirans, and from there about 1,300 kw. are conveyed to Voiron and about 1,600 kw. to Rives. As these districts are already supplied with lighting installations, all the energy is sold for power-supply. The industries are diverse in character, including paper factories, mills, collieries, and silk factories, and as most of these require a constant speed of motor irrespective of the load, which often changes suddenly and very considerably, it was decided to use only asynchronous motors. The users may have supply at 1,000 volts or at low tension, and according to the choice the transformation from the line voltage is performed at one operation or in two steps. The ratio of transformation adopted is 26,000 to 2,000, or 26,000 to 1,000, but one transformer of 150 kw. capacity transforms directly from the line voltage to 120 volts. There are eleven main substations, and the transformers are of three types—500, 300, and 150 kw. Where double transformation is made, the second transformer is placed on the premises of the user, as near as possible to the motors to be supplied. These transformers are of 100, 50, and 30 kw. capacity. The price charged to consumers for power is £6 per h.p. per annum for continuous use, but the rate varies for intermittent use. W. C. H.

429. *Swan Falls Power Transmission, Idaho.* **E. J. Koppitz.** (Journal of Electricity, S. F. 12. pp. 185–188, Oct., 1902.)—The power-house is at Swan Falls, on Snake River, where there is a fall of 10 ft., which has been increased by damming to one of 17 ft. There are four vertical McCormick turbines running at 78 r.p.m. These are all connected by clutches to one line of shafting, from which the generators are driven by belts. The two-phase alternators each give an output of 300 kw. at 500 volts and 60 cycles, running at 514 r.p.m. Transformers raise the pressure to 22,000 volts with three-phase current. The power is transmitted over a distance of 32 miles to the Trade Dollar Mines. W. H. S.

430. *Valtelina Railway.* **Fumero.** (Elettricità, Milan, 21. pp. 691–714, Nov. 2, 1902.)—The application of electric traction to the line from Lecco to Sondrio is a preliminary experiment with a view to much more extensive applications to the Italian railways which may, at an early date, be worked directly by the Government instead of being leased, as at present, to companies. The fall at the power station is 80 m., with a minimum flow of 25 c.m. per second. There is a canal 4,800 m. long, having 15 tunnels, of which the longest is 770 m. long. The canal is 4 m. wide at the bottom; the sides have a batter of 1 in 10, and the wetted section is 10 sq. m. The sides and bottom are lined throughout with cement to prevent loss by filtration and to facilitate the flow. The fall in the canal is 1 in 1,000. From the end of the canal the water is carried through two pipes each 2·5 m. in diameter and 68 m. long inclined at an angle of 45°. Each pipe line feeds two turbines which are overhung on the alternator shafts. There are three alternators of 2,000 h.p. each and one of 3,000 h.p., all running at 150 r.p.m. The turbines are of the Francis type and were built by Ganz & Co. The alternators, built by Schuckert & Co., have external fixed armatures and 12-pole rotating fields. They work at a tension of 22,000 volts. The exciters are direct-

Digitized by Google

coupled, but are themselves excited from a small auxiliary dynamo and turbine. The external diameter of the alternators is 5 m.; they weigh 70 tons, the weight of the rotating part being 44 tons. The switchboards, also built by Schuckert & Co., contains high-tension switches of the "horn" type—similar to the lightning arresters which are outside the building. There are also "water-jet" lightning arresters, consisting of a fine jet through which the different lines are connected to earth. The *high-tension line* is of 8 mm. wires from Morbegno to Colico, and of 7 mm. wires for the rest of the 90 km. over which it extends. It is carried on four-shed porcelain insulators, and is run on the same poles as the trolley line except where the latter passes through tunnels where it is carried outside. *Transformer stations.*—These are nine in number, the average distance apart being 8 or 9 km. They each contain three-phase transformers for 450 apparent kw. stepping down to 3,000 volts. All transformer stations are in parallel on both primary and secondary sides. The *trolley wires* have been calculated for a maximum drop of 5 per cent. in the tension. The two wires are 90 cm. apart and are carried on bracket poles at 40 m. intervals in the straight track. On curves span wires are used, and the supports are as close as 26 m. Ambroin is used for the suspension insulators and the span wires are further insulated with porcelain. [See also Abstract No. 2486 (1901).] A. E. L.

431. *Power-house of the Berkshire Street Railway Company, Pittsfield, U.S.A.* (Street Rly. Rev. 12. pp. 813–817, Nov., 1902.)—Power is generated at 13,300 volts three-phase and transmitted to two substations, 13 and 23 miles distant, where it is converted to 600 volts direct current. Part of the power is also converted in the generating station. The boiler-house contains four water-tube boilers working at 150 lb. pressure per square inch, each having 3,980 sq. ft. heating surface and 68 sq. ft. grate surface, and being rated at 11,800 lb. of water evaporated per hour. A large Cochrane feed-water heater receives the exhaust steam from the auxiliary engines, and the Holly system is used for returning condensed water from the steam pipes to the boilers. Two Goubert feed-water heaters are also installed, and a set of jet condensers. Coal is fed to the boilers by hand, special trucks being used to bring it to the furnace doors. The stack is 175 ft. high, 8 ft. diameter inside. The generating plant consists of two 750 kw. three-phase Westinghouse alternators, driven at 94 r.p.m. by horizontal cross compound condensing Rice & Sargent engines, and giving 32·6 amperes per phase at 13,300 volts, 25 cycles per second. Two Westinghouse exciter sets of 20 kw. each are provided. The engines have cylinders 22 and 44 inches in diameter, stroke 48 ins., and are fitted with a special type of valve gear, both cylinders being controlled by the governor. The flywheel weighs 50,000 lbs. and is 18 ft. in diameter; the maximum angular variation during one revolution is not more than 0·185° at 1,400 h.p. A reheating receiver is fitted, and very complete lubricating arrangements are provided. The article is illustrated. [See also Abstract No. 1247 (1902).] A. H. A.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

432. *Report of Committee on Standards of the American Street Railway Association.* (Street Rly. Rev. 12. pp. 853–854, Nov., 1902.)—This was

[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

Digitized by Google

adopted at the Detroit meeting in October, 1902, and is a revision of the report presented in 1901 [see Abstract No. 245 (1902)]. *Rails.*—The committee recommended the adoption of either a T or girder rail, the weight to be not less than 70 lbs. for the T-rail, and not less than 90 lbs. for the girder rail per yard. Illustrations are given showing the sections proposed. The width of head to be not less than 3 in. The committee considers the T-rail most desirable, and should be used whenever possible, but when girder rails are used the wheel bearing should be placed directly over the centre line of the tread. *Motors.*—It is practically impossible to standardise street railway motors, owing to the varying conditions to which they are subjected. *Trucks.*—The committee cannot recommend any particular design of truck, but gives dimensioned drawings of axles, journals, and journal boxes which are recommended. *Car Wheels.*—Dimensioned drawings of a steel-tired wheel and a cast-chilled wheel are given, and recommended as standards. *Brake-Head and Brake Shoe.*—A design for a standard type is given. *Painting.*—A standard specification for outside and inside painting is given. *Overhead Construction.*—No recommendations are made. F. B.

433. *Surface-Contact Systems.* **G. Paul.** (Engineering, 74. p. 671, Nov. 21, 1902). (Extract.)—This is an abstract of a paper in which the Author severely criticises the Diatto system [see Abstract No. 116 (1903)], as used in Lyons, Tours, and Paris, and the Dolter system [see Abstract No. 234 (1903)]. Referring to the cutting out of a live stud, he says this does not proceed in so rapid and precise a manner as is claimed, since, owing to the residual magnetic flux (and this is an inherent feature of the Dolter system, the studs being of cast iron), the contacts do not open instantly. E. K. S.

434. *Pneumatic Brake Trials.* (Elect. Rev. 51. pp. 849–850, Nov. 21, 1902.)—The importance of suitable and adequate brakes on electric tramcars is now being realised. The extra cost must not be thought of, for neglect to provide such is not only a grave omission, but also false economy. The human element is an important factor, and a driver should be as much alert at the end of his shift as at the beginning. This is impossible, owing to mental and physical strain, but a driver's consciousness of complete control of his car would do much to reduce mental strain, and the physical strain can be reduced by substituting the hand brake by a good mechanical service brake. The Hewitt and Rhodes pneumatic slipper brake appears to meet the requirements. It was subjected to a series of tests at Stockport on November 18, 1902, and the following are some of the tabulated results :—

STOCKPORT CAR TESTS.

TABLE I.

Trial of Emergency Brake on Steep Incline.

No. of Test.	Speed in Miles per hour.	Gradient.	Distance pulled up after Brake was Applied.	Number of Passengers.
1[1]	12	1 in 16	43 ft. 0 in.	8
2[1]	15	,,	80 ft. 0 in.	8
3[1]	20	,,	59 ft. 0 in.	6
4[1]	25	,,	69 ft. 6 in.	6

[1] Lancashire Hill.

Digitized by Google

TABLE II.

Trial of Emergency Brake on Ordinary Route.

No. of Test.	Speed in Miles per hour.	Gradient.	Distance pulled up after Brake was Applied.	Number of Passengers.
1A	27	Slight decline	56 ft. 0 in.	6
2A	25	,,	68 ft. 6 in.	6
3A	22½	,,	84 ft. 0 in.	6
4A	25	,,	48 ft. 6 in.	6
5A[1]	20	,,	50 ft. 0 in.	6
6A[2]	20	,,	64 ft. 0 in.	6
7A[3]	30	,,	72 ft. 6 in.	6
8A	20	,,	48 ft. 3 in.	6
9A[4]	17	,,	29 ft. 0 in.	6

[1] Same route as test 1A. [2] Same route as test 2A. [3] Same route as test 3A. [4] Same route as test 4A.

TABLE III.

Trial of Hand Brake made for Comparison.

1B[1]	17½	Slight decline	156 ft. 0 in.	6
2B[2]	19½	,,	324 ft. 0 in.	6
3B[3]	22	,,	337 ft. 6 in.	6

[1] Same route as test 1A. [2] Same route as test 2A. [3] Same route as test 3A.

TABLE IV.

Trial of Service Brake on Steep Incline.

1C[1]	5 approx.	1 in 16	24 ft. 6 in.	6
2C[1]	5 ,,	,,	24 ft. 3 in.	6
3C[1]	5 ,,	,,	13 ft. 0 in.	6

[1] Lancashire Hill.

TABLE V.

Trial of Service Brake on Ordinary Route.

1D	10	Slight decline	8 ft. 0 in.	6
2D	14	,,	18 ft. 0 in.	6
3D	15	,,	30 ft. 6 in.	6

Particulars of Car.—Weight of car about 10 tons (empty); wheel base, 6 ft.; carrying capacity, 57 passengers; length of car body, 16 ft.; length over platforms, 27 ft. 6 in.; diameter of wheels, 30 in.; motors, two of 30 h.p.; reversed staircases. E. K. S.

435. *Prevention of Electrolysis by Earth Returns.* **A. Larsen.** (Elektrotechn. Zeitschr. 23. pp. 868–870, Sept. 25, 1902.)—The author has carried out a series of tests which tend to prove that electrolytic corrosion due to stray

Digitized by Google

currents from tramway circuits may be lessened by periodically reversing the direction of the current. If the current is reversed in direction once a day, the corrosion is reduced to one-fourth of the normal amount; and if the current is reversed once an hour, it becomes about one-thirtieth of the same amount. The experiments which are here more particularly described extended over a period of three months at the beginning of the year 1902. Some cast-iron pipes 9 ft. long were cut in two; the diameters of the pipes were in some cases 6 in., and in others 4 in. Each length was buried in a separate box together with an iron plate, which served as the other electrode, the whole being filled in with a sandy mixture, which consisted of 80·3 per cent. of sand, 0·16 per cent. of soluble matter, including 0·084 per cent. of sulphates and a trace of chlorides, 4·7 per cent. of organic matter, and the remainder consisted of moisture. All the pipes were carefully weighed at the start. One series was exposed to a continuous current, unchanged in direction; these are called the *a*-pipes. The other pipes, exactly similar to the foregoing, were joined up in series with the corresponding *a*-pipes, but by means of a switch the direction of the current through them was periodically changed, in some cases once an hour, in others once a day. This second series is referred to as the *b*-pipes. At the end of the three months the pipes were examined. All the *a*-pipes were found to be much corroded, and had pittings on the surface. The *b*-pipes had only a slight surface of rust in those cases in which the current had been changed hourly in direction; and there was slight corrosion, but no pitting, in those cases in which the current had been changed daily in direction. The surfaces of all the pipes were carefully scraped and cleaned, and they were then weighed. After this cleaning the pipes were left exposed to the air for some days, and in the course of ten days the *a*-pipes showed signs of scaling on the surface, particularly round the spots where the pittings had formed; and thus it became evident that the corrosion had extended further than was at first visible to the naked eye. These scales were therefore scraped off and weighed. The results of the experiments are given in the following table :—

Diameter of Pipe in mm.	Mean Current Strength in Amperes.	Pipe.	Ampere Hours.	Direction of Current Changed.	Loss of Weight in Grammes.	Amount Scaled off in Grammes.	Total.
150	0·301	*a*	608	0	590	265	855
		b	+304 −304	hourly	27	0	27
100	0·121	*a*	244	0	231	90	321
		b	+122 −122	hourly	10	0	10
150	0·341	*a*	570	0	508	194	702
		b	+285 −285	daily	126	38	164
100	0·124	*a*	208	0	202	72	274
		b	+104 −104	daily	67	3	70

W. H. S.

Digitized by Google

436. *Accumulator Locomotives for Goods.* **T. J. Fay.** (Elect. World and Engineer, 40. pp. 674–676, Oct. 25, 1902.)—The author considers the use of accumulator locomotives in cotton and flour mills, &c., when the trolley is inadmissible on account of the risk of fire. In such cases he runs the motor in oil, and also submerges the battery and all connections in oil. This method he finds satisfactory. The motors are carried above the platform, and the power is transmitted by "Renold" chains. Radial trucks are used, so that a curve of only 12 ft. radius is traversed without much increase in current. A 15-ton locomotive is 22 ft. 6 in. in length, with 8 ft. 6 in. wheel base, and is equipped with two 15-h.p. motors and a battery of 48 cells, having a capacity of 500 ampere-hours at an 8-hour rate. The battery output per ton-mile (gross, including locomotive) is given as 112 watt-hours per ton-mile on the level, 552 on a 5 per cent. grade, and 952 on one of 10 per cent. An instance is mentioned in which horse traction at a cotton mill was advantageously replaced by accumulator traction. W. R. C.

437. *Wear of Steel Tyres in Germany.* (Railroad Gazette, 34. pp. 710–711, Sept. 12, 1902.)—This is an abstract of the summary of a report on the wear of steel tyres on German railroads covering a period of ten years, and including all the wheels running under the cars of the German Railway Union. The statistics show that the breakages of cast wheels have increased of late years, whereas those of steel tyres have decreased. Breakages are more frequent where a brake is applied. In cold weather the breakages are more frequent and more serious. The proportion of breakages to the total number of failures decreased as the thickness of the tyres decreased, while the proportion of cracked tyres increased. This means that whilst the new tyres broke the old ones cracked.

The greatest number of breakages in locomotive tyres occurs when a mileage of 62,000 has been run. The conclusions are that there is a steady improvement in steel-tyred wheels; that Bessemer steel, though showing fewer breakages than iron, shows a tendency to fail in winter; that cast wheels are not so good as steel-tyred wheels. Seven illustrations of tyre attachments are given. F. B.

438. *Carriage of Fruit by Electric Railway.* (Street Rly. Rev. 12. pp. 818–820, Nov., 1902.)—A description is given of the method of handling baskets of peaches in vans with removable shelving, as used at Buffalo, U.S.A. A car 35 ft. long will hold 1,000 baskets, without risk of injury and with perfect ventilation. The tariff is 40 cents per 100 lbs., or about 8 cents per basket, for any distance up to 40 miles. Drawings of the cars are given. A. H. A.

REFERENCES.

439. *Protection of Long-Distance Transmission Lines.* (Eng. News, 47. pp. 486–488, June 12, 1902. This is an abstract of a joint paper by **C. H. Baker, L. Denis, P. N. Nunn, H. J. Gille,** and **P. M. Lincoln,** read at the Annual Convention of the Nat. Elect. Light Ass., Cincinnati, May.)—It relates to high-tension overhead transmission lines of from 25,000 to 60,000 volts.

440. *Power Plant at the Elizabethport Shops of the Central Railroad of New Jersey.* (Eng. Record, 45. pp. 581–583, June 21, 1902.)

441. *Slow Speed Generating Units at Louisville, Ky.* (Street Rly. Rev. 12. pp. 841–842, Nov., 1902.)

Digitized by Google

TELEGRAPHY AND TELEPHONY.

442. *Mercadier's Multiplex Telegraph.* **J. Anizan.** (Journ. Télégraph. 26. pp. 73–77, April; 121–126, June; and pp. 145–149, July, 1902.)—Treats of further developments. The system was described in Abstracts Nos. 1995 (1899), 1388 (1900), and 2506 (1901). In the early apparatus the fork of the transmitter was mounted on a case with a microphone, the latter being

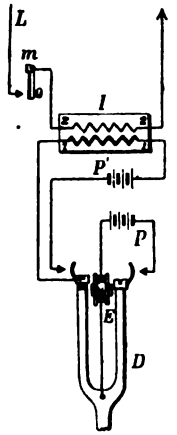


FIG. 1.

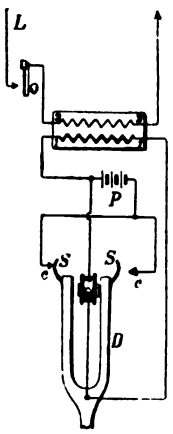


FIG. 2.

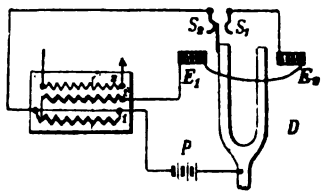


FIG. 3.

actuated by the vibrations of the former. But the microphone was dispensed with and the intensity of the current increased by the arrangements shown in the figures—the second being finally adopted as the left-hand style in the first was not found to make good contact. The author compares the transmitter with Varley's, shown in Fig. 3, which he thinks the most power-

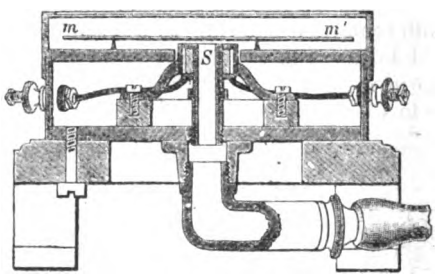


FIG. 4.

ful for long distances. The receiver, as shown in Fig. 4, differs from an ordinary telephone in the fact that the diaphragm rests freely on three points situated on the circumference constituting the nodal line of the first harmonic. The height of the sound varies with the diameter, and it is possible to regulate the discs for unison with corresponding forks or diapasons. In actual practice the disc is elastically fixed at the points. The electro-

Digitized by Google

magnet is bipolar, concentric, and polarised, the central pole being hollow and the hearing tube is fixed thereto. The receiver is very sensitive, strong, and cannot be deranged. Whatever may be the number of induced currents of different periods traversing the electromagnet, the disc will remain inert until the periodicity for which it is arranged occurs. Metallic circuits of

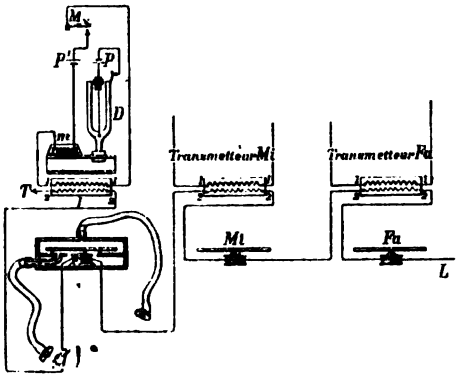


FIG. 5.

copper are preferred for Mercadier's system, for the instruments are subject to disturbances of the same order as telephones although less influenced by them. In each terminal office twelve receivers and twelve transmitters can be installed for one circuit. Three arrangements of the apparatus were successively tried. The first in series, shown in Fig. 5, succeeded in the laboratory

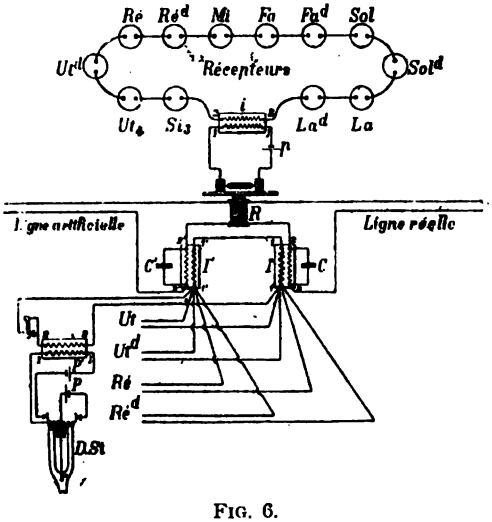


FIG. 6.

but failed on a real line. The receivers were disturbed by each sending diapason. The second grouping, with the employment of a microphonic relay, shown as R in Fig. 6, differentially wound, permits of all the receivers being undisturbed except for their own receiving notes. The receiver of a certain pitch remains mute even to the impulses of the diapason sending in

Digitized by Google

the same office at that pitch. This result has been achieved by means of the graduated condensers C and C′ which, according to Mercadier, almost entirely destroy the effects of self-induction of the induction bobbins, to equilibrate the self-induction which remains in the bobbins, the artificial line, the relay windings, and the real line, as well as to equalise the phase of the inverse currents which arrive each instant in the relay windings. Unfortunately the functioning of the relay proved to be inconstant. Hence the

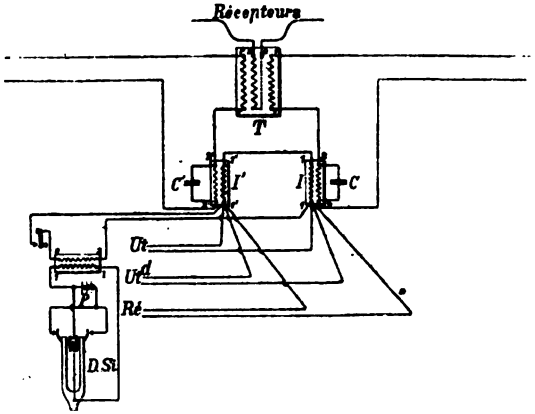


FIG. 7.

third arrangement shown in Fig. 7 was devised, where the microphonic relay was replaced by a transformer T, with triple winding. A modification of the arrangement of the induction bobbins, as shown in Fig. 8, was afterwards introduced. By this the resistance of the primary was reduced one-half, and there being two secondaries on one primary wound parallel, the difference of phase in the currents of the real and artificial lines was reduced.

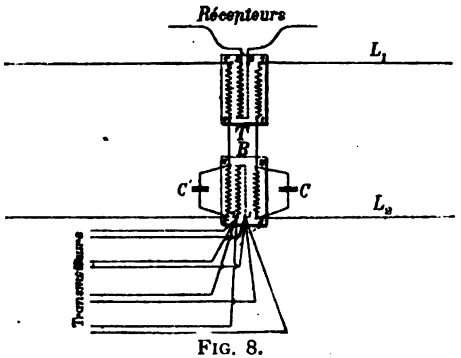


FIG. 8.

With these last arrangements a regular multiplex service was assured. To prevent any inconvenience that may possibly arise from a receiver being unduly influenced by its fellow diapason or sender, Mercadier has given a difference of a quarter of a tone to each which is said to have successfully met the difficulty. An ordinary telegraph apparatus can be introduced in derivation in the same circuit as shown in Fig. 9, a Baudot, or Wheatstone, simple or duplex. Experience gained between Paris and Pau as terminals, with Tours

Digitized by Google

Angoulême, and Bordeaux as intermediates, shows that the intensity of the signals exchanged between the terminals is not affected by the intermediate derivation circuits. The writer proposes to work a group of offices, such as might branch from a centre like Paris, by putting them all together with the central on one metallic circuit, by which there might be a saving in wire, and in transit work, as all the offices in such a group might intercommunicate with each other instead of employing the central office as intermediary. But he admits that no satisfactory system of ringing up has yet been devised for as many as twelve offices in one circuit. He shows that three offices can

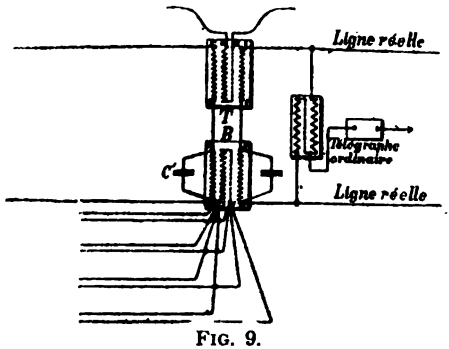
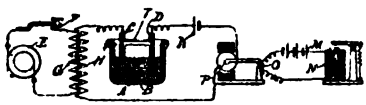


FIG. 9.

have calls installed, using polarised bells and positive and negative currents. He is hopeful of devising some means for twelve offices. With two terminal stations only Mercadier's system can be worked 2,000 km., but the writer thinks that this distance would be considerably decreased for twelve stations. The writer thinks it not impossible that twenty-four stations may at some future time be worked at one circuit, or a total of forty-eight messages, exchanged simultaneously by arranging the discs so that they differ in note by a quarter tone, and the fellow-receiver and transmitter by one-eighth of a tone. To this effect he would support the disc of a receiver on points.

E. O. W.

443. *Pupin's Asymmetrical-Current Device for Telegraph Circuits.* (West. Electn. 31. pp. 844–845, Nov. 15, 1902.) — With asymmetrical alternating electromotive force in circuit an asymmetrical current is produced by opposing the current from a voltaic cell and a polarisation cell (say two platinum electrodes in dilute sulphuric acid), of large capacity reactance. The arrangement is shown in the diagram, in which K and T represent the two cells



referred to. It is stated that the invention is of value as a rectifier for alternating currents in telegraphy, and more particularly in multiplex telegraphy by resonance-receiving circuits. It rectifies Hertzian oscillations, as well as those of ordinary frequencies used commercially. When a circuit is properly adjusted for a given frequency it will even better rectify with all lower frequencies.

E. O. W.

Digitized by Google

444. *Hamburg Telegraph Station.* **Grallert.** (Archiv Post Tele. 17. pp. 532–546, Sept., 1902.)—The Post Office Telegraph Department of Hamburg has recently been removed to a new building. The paper describes the changes and improvements that have been carried out in connection with the re-installation of the apparatus. A plan of the new premises is given, showing the arrangement of offices, instrument-rooms, and rooms for testing and instruction. It also states the number and kind of instruments installed. The chief point of interest appears to be the adoption of the Gutknecht system of pneumatic transmission for local purposes. The carrier tubes are made of celluloid. They are blown through a transmission tube 63 mm. in diameter. The system is provided with an electrical control which automatically locks the door of the receiving box during the insertion of the carrier tube at the sending end until its arrival. The arrival is indicated by a red glow-lamp. The switching arrangements are actuated by the doors of the sending and receiving boxes, so that, so far as the operators are concerned, the apparatus is entirely free from complication. R. A.

445. *Improved Electrograph.* (Scientific American, 87. pp. 329–330, Nov. 15, 1902.)—The machines are motor-driven by storage batteries, as potential must be constant. In order to transmit a picture, a transmitting cylindrical sheet of zinc is employed, which is merely an enlargement of a half-tone plate of the picture. Since the variations in the surface of the zinc sheet cylinder are considerably more pronounced than those of the small original, the transmission of lights and shades is facilitated. The interstices of the zinc plate are filled with a non-conducting material, so that the entire surface is perfectly smooth. Thus treated, a zinc sheet presents a fairly smooth, partially metallic and partially insulated surface. The filled zinc plate is curled around the cylinder of the transmitting machine. Upon the surface of the zinc plate glides a stylus, which is caused to travel along the rotating cylinder by means of a carriage, very much as the reproducing stylus of the phonograph is caused to travel along the sound record. Thus the stylus comes into contact with every portion of the transmitting cylinder, describing a continuous spiral as the cylinder rotates and the carriage travels. Upon a piece of ordinary paper wrapped upon the cylinder of the receiving instrument plays an inked pen, which is caused to travel along the cylinder. Since the same instrument can be used either in transmitting or receiving messages, the carriage is provided with both a stylus and a pen so mounted that either can be thrown into or out of operative position. The stylus, as the cylinder rotates, glides over a surface partially metallic, partially insulated. When in contact with the metal a circuit through the line and receiving instrument is completed, and a line or dot is traced by the pen of the reproducing instrument, corresponding in length with that traced by the transmitting stylus. When the stylus is in contact with an insulated portion of the zinc sheet, the circuit is broken, and the pen of the receiving instrument is withdrawn from the paper. Thus an electrogram, a facsimile of the original picture, is made. The pen is, of course, worked electromagnetically. It is essential that the cylinders at the transmitting and receiving ends should move synchronously. Hence about one-eighth of each revolution is used for throwing the regulating relay into operation when a cam on the main shaft cuts out the picture circuit. To prepare a zinc enlargement, transmit the picture (occupying a cylinder 24 in. long) over 1,500 miles, and reduce the electrogram for the press, occupies about 80 minutes. E. O. W.

Digitized by Google

SCIENCE ABSTRACTS.

Section B.—ENGINEERING.

JUNE 1903.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

446. *Action of the Engine Governor in Parallel Running of Alternators.* **de Marchena.** (Soc. Int. Élect., Bull. 2. pp. 754–799, Nov., 1902.)—In this paper the author discusses mathematically the effect of faulty governing on parallel running. Too great importance has been attached to irregularity of turning moment; resonance can only occur when the number of impulses per minute is very near to the natural oscillation period of the alternator, which is not usually the case. As a preliminary, the author deduces mathematically an expression for the angle of displacement produced in an alternator at a given speed and under a given load, by a single impulse of the motive power, and thence infers the necessity for the governor to pass from one position of equilibrium to another on any change of load, with rapidity, precision, and the minimum of oscillation. The last point is then treated in detail, the following classes of oscillation being studied in order: (1) Those peculiar to the governor considered alone; (2) those peculiar to the system formed by the governor, engine, and flywheel; (3) those peculiar to the engine and its accessories in combination with the alternator coupled to the mains. Two classes of governor are considered: those in which the statical effort, which opposes the centrifugal force, is produced by the action of gravity alone; and those in which it is produced by the combined action of gravity and springs. In both cases the result is arrived at that the displacement of the governor sleeve is approximately proportional to the variations of speed. Expressions are then deduced, which are found to be similar in each case, for the alteration produced in the speed by an increment of the statical effort, to which it is found to be inversely proportional; and for the effort required to keep the sleeve of the governor displaced from its position of equilibrium by a quantity Δz, which is found to be proportional to the ratio of this displacement to the total range. Oscillations peculiar to the governor, considered alone, are then discussed mathematically, with the practical conclusion that in order to reduce the period and the amplitude of the oscillations it is necessary to avoid too close an approach to synchronism, to reduce inertia, producing as much as is possible of the statical effort by means of springs, and to keep the total displacement of the governor small. The effect

Digitized by Google

of damping is considered; this consists of two terms, frictional damping, which is constant, and oil-dashpot damping, which increases with the speed. Calling this last term $R\,dx/dt$, and neglecting at first the effect of friction, the differential equation of the movement of the governor sleeve (x being the displacement, A the statical force at unit displacement, M the inertia) is $Md^2x/dt^2 + Rdx/dt + Ax = 0$. The oscillations expressed by this are zero if R is equal to or greater than $\sqrt{4AM}$. The critical value of R is reached more quickly for the same value of A in proportion as the inertia is less. Hence another advantage of spring control in governors. Putting $R = \lambda\sqrt{4AM}$, a table is calculated showing the value of the damping effect for different values of λ, and it is shown that when λ is greater than 0·5, the oscillations are practically negligible. Taking into account, next, the effect of friction, this is shown to be, from the point of view of damping, an advantage; but as it tends to reduce the sensibility of the governor, it should be kept within such limits that f/A (f = the friction) represents only a small fraction of the total displacement. As regards inertia, while it has been shown that it is from one point of view harmful, it has the advantage of opposing too great variations in the speed of the governor sleeve such as might be produced by irregularity of turning moment, &c. For reciprocating engines, therefore, a certain amount of inertia in the governor is necessary; but for turbines and the like, where the motive force is regular and free from impulses, the statical effort should be produced entirely by springs. After a calculation of the periodicity of oscillation of different types of governors (some numerical results, varying from ½ a second to 2 seconds, being tabulated), the author proceeds to discuss the theory of the oscillations in the whole system of the governor engine and dynamo together, the case of an alternator running in parallel being excepted; the conclusion arrived at being that in order for the oscillations of the governor to be rapidly damped, the expression $W_m/EU(t + \theta)$ should be sensibly less than unity; where W_m is the maximum power of the engine, E the increment of speed at the increased load, U the *vis viva* of the whole system, t the time in seconds occupied by the governor sleeve to attain its new position, θ the interval which elapses between the governor reaching its new position and its effect being felt on the engine. The expression EU/W_m represents the time which the engine would take to accelerate by the quantity E under the effect of the full load W_m. The broad result may be stated thus: "The flywheel should be more sluggish than the governor." As regards weight of flywheel, an expression is deduced for the *vis viva* which the flywheel should have per unit of maximum engine power, for perfect speed governing, quite apart from considerations of angular displacement. The weight of flywheel ought to be greater (1) in proportion as the ratio inertia/governor effort is greater; (2) as the maximum displacement of the governor sleeve is greater; (3) as the isochronism is more nearly perfect, and (4) as θ (the lag of the governor effect) is greater. Roughly, θ may be taken as ¼ of the time of one revolution for engines with single expansion, and half of this value for those with multiple expansion. The author then considers the effect produced on the governor when the alternator is coupled in parallel on the mains. In this case, even if the governor is not susceptible of oscillations in itself, these will be liable to be impressed upon it by the pendulum action of the flywheel. Taking this into account, a differential equation is evolved for the movement of the governor sleeve, which is found to be oscillatory and of which the frequency is the same as that of the pendulum action to which it is due; expressions are given for the lag and amplitude of the oscillations and for the damping in terms of the

Digitized by Google

known quantities. When the coefficient of damping λ is zero, and there is resonance between the natural oscillation period of the governor and the pendulum movement of the alternator, there result, as might have been expected, governor oscillations of wide amplitude for very slight variations of flywheel speed. With damping, *i.e.*, when λ is not zero, the perturbations do not attain their maximum value when there is resonance, but for a frequency of the pendulum movements of the alternator higher than that corresponding to resonance. Curves are given showing the ratio x_1/x_0 as a function of T/T_0 for different values of λ; (x_1 = amplitude of governor oscillations with damping, x_0 — the same without damping, T = time in seconds of one oscillation of the governor, witb damping, T_0 = the time of a natural oscillation of the governor, undamped, λ = damping coefficient). The practical results brought out are (1) that, in the neighbourhood of resonance only, the value of λ is very important, but otherwise it has little effect; (2) that to make x_1/x_0 small, either λ must be very large or the natural period of the governor T_0 must be large compared with T. So far as possible the oscillation period of the governor should be higher than that of all the pendulum movements which tend to produce it. These latter are of two kinds: (1) arising from a periodic irregularity of driving torque, the effects of which are therefore permanent, and (2) from sudden non-periodic irregularity, the effects of which last only a short time after the causes which give rise to them. The first have been studied by David and Boucherot [see Abstracts. Nos. 940 and 942 (1902)]. Large inertia in the governors, necessitating heavy flywheels, is required to reduce the amplitude of oscillations arising from this cause in plant running at moderate speeds; at high speeds the effects are less marked and spring governors with small inertia and light flywheels can be used. For the second class of pendulum movements, damping the governor is the remedy; either by increasing the friction, which is bad, as the sensibility is decreased, or by increasing the power of the oil brake. In this connection, the advantages of the bypass dashpot governor are explained [see Abstract No. 1175 (1900)]; but its tendency is to make the governor sluggish, and another solution is preferred by the author as not having this defect, namely, to actuate the governor, not directly by the engine, but by a small induction motor on the mains. Thus the governor is unaffected by cyclical variations in flywheel speed, and responds only to changes of speed due to alteration of load or permanent alteration of driving power. A special safety device, which is described, must be employed, by which in case of a fuse blowing in the motor circuit the governor is automatically geared direct to the engine. At the first trial of this arrangement the motor was found to hunt, the oscillations being of small amplitude and long period. The reason of this is deduced mathematically, and explained as being due to the use of a motor of too small power and with too much slip; when a larger motor with smaller slip was substituted the hunting disappeared. B. P. S.

447. *Engine Governors for Parallel Running.* **G. R. J. Parkinson.** (Elect. Rev. 51. pp. 982–983, Dec. 5, 1902.)—The conditions for good parallel running are—even turning moment in the engines and constancy in supply of power during the oscillations necessarily set up when one engine from any cause lags behind the other. The second condition depends on the governor. For lighting work, if the governor is of moderate range, say 3 to 4 per cent., it should be of a slow-acting type; quick-acting governors, *i.e.*, spring-controlled and of small inertia, must have a wider range, say 6 or 7 per cent. For power work with sudden changes of load this large drop in speed is a

Digitized by Google

disadvantage, and one with a smaller drop and less rapid in action should be preferred—either a spring governor with a powerful dashpot or a dead-weight governor with considerable inertia. B. P. S.

448. *Sugden Water-tube Boiler.* (Elect. Rev. 51. pp. 1045–1046, Dec. 19, 1902.)—This boiler is of the horizontally inclined tube type, but has straight headers, square in section, made of solid drawn steel, so that the water-tubes are not "staggered." Baffle plates are laid along the tubes and are arranged so that the bulk of the flame and hot gases is made to travel along the first four or five rows of tubes to the back headers and then along the upper rows to the front, after which the hot gases pass along the superheater tubes and down behind the rear headers to the chimney flue. A few holes made in the first baffle plate over the fire allow some of the hottest gases to escape directly upwards, and the intention is that the flame at this point, meeting the gases which have been cooled by contact with the water-tubes below, will reignite any portion of the gases which has not been completely consumed. The superheater is composed of a row of straight tubes laid horizontally from a circular drum at the rear to a horizontal header at the front, placed between the top of the water-tubes and the horizontal steam and water drums of the boiler. The steam enters one half of the rear drum, passes through half of the superheater tubes to the front header and back to the drum by the other half. A relief pipe is provided which discharges the superheated steam into the boiler when steam is first being raised. This pipe has a valve actuated from the stop-valve so that it is closed when the stop-valve is open and *vice-versâ*. F. J. R.

449. *Flash Boilers.* **J. S. V. Bickford.** (Engineer, 94. p. 514, Nov. 28, and pp. 538–540, Dec. 5, 1902.)—The ordinary water-level being absent from these boilers the feed must be controlled by the steam pressure. In some, as the Serpollet, both the fuel and the water are supplied in fixed proportions to maintain a given steam pressure without reference to water-level. Where the fire is constant and the demand for steam variable the water contents will vary with every change in steam output, and if under a variable demand for steam it is desired to maintain the water content uniform the intensity of the fire must be varied. The author points out the difference between the ordinary so-called "flash boiler" and the real flash boiler; also between ordinary water-tube boilers and boilers of the so-called flash boiler class, pointing out the friction caused by a long length of pipe due to coils in series and the causes of fluctuations of steam pressure. As to durability, the conditions under which the flash boiler works do not induce long life, but such boilers are not expected to last as long as others. Some experiments on the durability of different forms are referred to. The efficiency of flash boilers is comparatively low, and the author concludes from experiment that in practice it would be an exceptional boiler of this class which would show an evaporation of more than 8 lbs. of steam per lb. of oil fuel, the oil being of 18,000 B.Th.U. per lb. Experiments as to output convinced him that 12 lbs. of steam per sq. ft. of heating surface per hour could be got only by an extravagant consumption of oil fuel, and that in practice it is not wise to expect more than a maximum of 7 lbs. per sq. ft., or at the outside 8 lbs., and that 5 lbs. is the limit for ordinary commercial work, as in marine and land boilers. Feed control by relief valve has been universally tried, but according to the author has been given up. The objections to this system of working and the difficulties experienced are described, and the author

Digitized by Google

then mentions three ways of overcoming the difficulty of feed control, viz., the plan of the White Sewing Machine Company, which uses a diaphragm valve controlling the feed suction or delivery from the pump, the diaphragm being subject to the boiler pressure on one side and controlled by a spring on the other; the Serpollet car arrangement of two barrels of different capacities to the feed pump, one delivering water and the other oil for fuel; and third, that of introducing a check valve between the water relief valve and the boiler. The feed-pump being the vital organ of the flash boiler must be reliable. There should be two or three suction and delivery valves in series; the feed-water should be filtered, and the pump must work below the level of feed supply to be always flooded. Methods of providing reserve or emergency feed supply are alluded to, and then fire control by thermostat from the temperature in the lower coils of the boiler (as in the White car), or from that of the steam, is discussed. As to scale in the boilers, it is found that the solids from some waters appear as dust in these boilers, and this is more a danger to engine than to boiler. Some few results as to variation of steam pressure from a boiler in action conclude the papers. F. J. R.

450. *Hohenstein Water-tube Boiler.* (Eng. Record, 46. pp. 586–587, Dec. 20, 1902.)—This boiler was used in tests with coal and oil fuel referred to in the annual report of Admiral Melville [see Abstract No. 884 (1903)]. It is of the horizontally inclined tube type, these tubes being arranged in sets of six vertically, inclined alternately from back and front, giving a form of two interlacing Vs placed sideways, thus ⋈. From a transverse water-drum at the bottom of rear header 16 4-in. tubes 7 ft. long are placed in one layer extending to the front lower headers which embrace the ends of each six water tubes in a vertical row. These six tubes pass to junction boxes at the back and then to another short header at the front, at the top end of which header is a transverse steam drum. The same arrangement is repeated in the opposite directions commencing at the back. The upper transverse drums are each 24 in. diameter, and are connected by four horizontal drums 16 in. diameter. There are 384 inclined tubes 2 in. diameter, 9 ft. long, besides the 16 water tubes mentioned above. There are also 15 downtake tubes, 5 in. diameter, connecting the two rear transverse drums. The floor space occupied is 9 ft. by 11 ft. Heating surface was 2,174 sq. ft. for coal tests 15 to 20 inclusive, and 2,180 for coal tests 21 to 31. Grate surface, 50·14 sq. ft. The air spaces in grate bars for coal tests were $\frac{5}{8}$ in. for tests 15 to 25 and $\frac{1}{2}$ in. for tests 26 to 31. Fourteen tests were made with oil fuel and 17 with coal, some of each series being conducted with chimney draught and some with forced draught. In the oil tests the evaporation from and at 212° F. per hour per sq. ft. of heating surface was, lowest 3·91 lbs. (chimney draught), highest 16·7 lbs. (forced draught); with coal, lowest 4·88 lbs. (chimney draught), highest 14·15 lbs. (forced draught). These were tests Nos. 9 and 8 of the oil series and 25 and 31 of the coal tests.

With the oil tests the efficiencies were, in No. 3 test, of boiler only 71·5 per cent., of boiler and furnace 70·7 per cent., these being the highest with oil, and in No. 8 test, boiler 53·4 per cent., boiler and furnace 51·1 per cent. the lowest. With coal No. 25 showed, boiler only 73·4 per cent., boiler and furnace 65·4 per cent; No. 18, boiler 71·8 per cent., boiler and furnace 68·8 per cent., and No. 31, boiler 59·4 per cent., boiler and furnace 54 per cent.

A full table of the tests, analyses of the coal, oil, and waste gases, and illustration of the boiler accompany the Report. F. J. R.

Digitized by Google

451. *High-Pressure Steam Piping.* **W. Andrews.** (Eng. Record, 46. p. 589, Dec. 20, 1902. Abstract of a paper read before the Engine Builders' Association of the United States.)—The introduction of high-pressure steam for stationary engines in America commenced only twenty-one years ago. In 1890 the high-speed, compound, non-condensing engines of the Edison Electric Light Company, of Brooklyn, worked with 150 lbs. steam pressure, and to-day pipes and fittings have to stand 20 lbs. pressure per sq. in. They are usually made of wrought steel, wrought iron being seldom used except for the larger sizes, and copper having been abandoned on account of its unreliability. The design of a system of piping for power plants, which was almost universal up till 1900, provided a pipe from each boiler to a large steam header having a cross-sectional area equal to that of all the feeding steam pipes combined, and from this header pipes of various sizes branched to the different engines with a steam separator on each line of pipe. This has been altered principally as regards the sizes of pipes used, these being in general smaller since superheated high-pressure steam was used. In the four large power-houses now built in New York City with an alternate capacity of from 60,000 to 100,000 h.p. each, the largest steam mains are not over 20 in. in diameter. Some of the best American plants have the pipes from the header to the engine two sizes smaller than that demanded by the engine builder, and there is interposed close to the engine a wrought-iron or steel receiver having a cubic capacity three times that of the high-pressure cylinder. The object of this arrangement is to have a full supply of steam close to the throttle valve and to provide a cushion near the engine on which the pulsations caused by the cut-off would be spent, thereby preventing vibration in the piping system. The small pipe leading into the receiver supplies enough steam to make up the quantity abstracted during the first portion of the stroke and causes a steady flow in one direction. The receiver also acts as a steam separator. It has been found that with this arrangement a drop of only 4 lbs. in the steam pressure is experienced even with engines 500 ft. away from the boilers. The vibrations which are often noticed with high-speed engines have been frequently due to bad design of the steam piping rather than to bad foundations. This paper also contains some useful considerations regarding pipe joints and steam valves. F. J. R.

452. *Rowe System of Burning Pulverised Coal.* (Eng. Record, 46. p. 592, Dec. 20, 1902.)—In using the cheapest kind of bituminous slack it is dried, so that the moisture does not exceed 2 per cent., and then is ground to pass through an 80-mesh sieve. The dust is stored in an iron storage hopper near the boiler, from which it is taken by a special conveyor to the spout or nozzle, when it comes in contact with hot air blown from a fan. Another nozzle just before entering the furnace further mixes the air and dust fuel which is then sprayed, by a cast-iron mouthpiece with a semicircular opening, upward against a brick arch. An illustration of this apparatus accompanies the paper. F. J. R.

453. *Lignite as a Fuel for Steam-raising.* (Engineer, 94. p. 229, Sept. 5, 1902.)—The *Elektrochemische Werke* at Bitterfeld, in Germany, are entirely operated by power derived from lignite. It is conveyed direct from the mines, which are near the works, into the bunkers supplying the boilers, by means of a wire rope system of transportation, and its cost at the boilers is only one-third that of ordinary coal. The calorific value varies between 2,600 and 2,800 calories. The boilers are provided with step-grates built on the

Digitized by Google

Keilman and Völcker system, the grate areas varying from 212 to 300 sq. m. The twenty-one boilers are of the water-tube type, supplying steam at from 120 lbs. to 135 lbs. pressure. The steam is superheated from 220° C to 260° C. The efficiency of the whole boiler installation works out to 70 per cent. The generating machinery comprises six 600-h.p. sets, and one of 1,800 h.p., coupled to continuous-current dynamos. G. W. DE T.

454. *Jet Condensers with Auxiliary Water-vessels.* **F. J. Weiss.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1449–1456, Sept. 27; 1494–1499, Oct. 4; and pp. 1591–1595, Oct. 18, 1902.)—In jet condensers, if the quantity of steam fluctuates rapidly between wide limits, as in the case of rolling mill engines, the vacuum may be kept steadier by providing a large reserve of water in the condenser. Constructive considerations make it preferable to provide this reserve in one or more separate vessels connected with the condenser. During periods of heavy steam consumption the water in these vessels gradually increases in temperature, while during periods of light load the temperature falls. The exact rate of rise and fall under various conditions is examined mathematically and examples are worked out. A. E. L.

455. *Wheeler Water-cooling Tower.* (Mech. Eng. 10. pp. 865–866, Dec. 27, 1902.)—The discharge pipe stands vertically in the centre of the tower and distributes into horizontal troughs at the top, from which troughs distribution pipes extend horizontally, having slots and holes for discharging the water. From these pipes mats of wire mesh, arranged in series, are suspended and are drawn taut and held in position by rods and angle-iron edgings. Valves are arranged in the discharge-pipe branches above, so that any one or any combination of the troughs and their series of mats may be used. The central space of the tower is used for air circulation and contains a number of bafflers or retarders also made of wire-mesh mats. They prevent the passage of strong currents of air across the tower and tend to cause an upward current. F. J. R.

GAS AND OIL ENGINES.

456. *Use of Blast-Furnace Gas in Gas Engines.* **C. A. Cochrane.** (Engineering, 74. pp. 794–796, Dec. 12; pp. 809–810, and p. 814, Dec. 19, 1902. Paper read before the Cleveland Institution of Engineers.)—The author describes the construction and performance of a 600-h.p. gas engine worked by waste gases from the blast-furnaces, which had been in use for twelve months at the Ormesby Iron Works. It was constructed by the Cockeril Company, and is in all respects similar to the one exhibited by that Company at the Paris Exhibition. The necessary reduction in temperature, a reduction averaging about 570° F., is effected by giving the gas a travel of 1,100 ft. at a slow speed. Arrangements were made to supplement this, if requisite, by the injection of water spray, but it has never been found necessary to make use of them. The gas is purified from dust by passing, in the course of its travel, through two fans. The first of these is run with water, which transforms most of the dust into mud, much of which is deposited in a hard mass on the fan-blades, from which it is removed every fourteen days. The Russian mineral oil known as "*Mazout*" is used for lubricating, the cost of which averages only 5s. 7¾d. per day while the engines are running continuously, and it includes the oil used in the blowing cylinder. G. W. DE T.

Digitized by Google

AUTOMOBILISM.[1]

457. *Reliability* 100-*Mile Tests of Cars.* (Automobile Club Journ. 4. p. 840, Nov. 20, 1902.)

Name of Car.	Weight of Car.	Weight of Passengers.	H.P. of Car.	Petrol used.	Water used.	Dashwood Hill, viz., 1,180 yds., averaging 1 in 16, part being 1 in 10·9.	Aston Hill, viz., 1 mile 1,100 yds., of which 1,910 yds. have a gradient 1 in 21.	Stops.	Speed overall.	Date of Trial.
Earl...	17¼ cwts.	5½ cwts.	9	4½ galls.	0·225 gall.	10·45 m.p.h.	10·2 m.h.p.	None.	Over 12 m.h.p.	Nov. 14, 1902.
Herald	19¼ cwts.	5¾ cwts.	12	5 galls.	2½ galls.	8·71 m.p.h.	8·75 m.h.p.	None.	Over 12 m.p.h.	Nov. 14 1902.

M. O'G.

458. *Steel Ball Bearings.* (Engineering, 74. pp. 833–836, Dec. 26, 1902.)—This article describes and illustrates some very novel forms of ball bearings which have been constructed by the Deutsche Waffen-und-Munitions-Fabriken of Berlin. The designs are the results of the theoretical investigations of R. Stribeck, and of practical experience with bearings constructed according to his designs, which led F. Heerwagen to confirm and extend Stribeck's results. These investigations were described in the Zeitschr. Vereines Deutsch. Ing. 45. pp. 78 *et seq.*, and pp. 1701 *et seq.* respectively, 1901. Both these writers base their researches on the work of H. Hertz on the deformations arising in perfectly elastic bodies of any curvature under pressure. A summary of Heerwagen's investigations is given in this article. It is found that, by grooving the ball-races, the stress and compression are materially diminished, while the load which each ball can bear under the same stress is considerably increased. In the theoretical investigations, neither friction nor dynamic conditions have been taken into consideration. With regard to the first of these points, the experimental results obtained both by Stribeck and Heerwagen show that the theory is in fair agreement with practice for the maximum loads admissible on bearings in which friction has been reduced as far as possible. With regard to the second point, the assumption that the forces are normal to the contact surfaces is confessedly unsatisfactory, and Hertz has indicated methods of attacking the problem which would make this assumption unnecessary. These methods, however, lead to very complex formulæ, and it would appear that the results obtained on the above-mentioned assumption may safely be taken as first approximations. The bearings, of which working drawings are given, include some for the differential gearing of automobiles, and for tramcars and full-gauge railway rolling stock, also for cranes and other purposes. It is stated that they have been run successfully for a year without attention after being once greased with vaseline, and at speeds up to 8,000 r.p.m. The normal ball bearing of this type consists of two concentric collars of hardened steel, well polished on the inside, and ground on their faces. The balls must of course be well hardened and thoroughly well polished. One collar is provided on the outside, with a semi-cylindrical or curved recess, into which fits a small locking-piece, held by a screw. The balls can be removed singly by taking

[1] Electric Automobiles are described in the Section dealing with Electric Traction.

Digitized by Google

out the screw and removing the locking-piece. This lock may be on either collar, preferably on the one on which it will be subject to the smallest stresses. With greatly fluctuating loads a bushing, consisting of two split conical parts, held by a nut, is interposed. G. W. DE T.

REFERENCES.

459. *Engines at the Glasgow Tramways Power Station.* (Engineer, 94. pp. 536–537, Dec. 5, and pp. 583 and 596, Dec. 19, 1902.)—A set of working drawings is here given of the smaller or auxiliary pair of engines at the Pinkston station of the Glasgow tramways. They indicate normally 800 h.p., but are capable at a slight sacrifice of efficiency of indicating 1,000 h.p. continuously, and 1,200 h.p. for short periods. [See also Abstract Nos. 2333 (1900).] G. W. DE T.

460. *Steam Turbines.* **K. Andersson.** (Inst. Engin. and Shipbuilders, Trans. 46. pp. 9–34, Nov., 1902.)—The paper treats mainly of the construction and performance of turbines of the de Laval type. Numerous tables are given showing the results of tests of de Laval turbines. G. W. DE T.

461. *Turbo-alternators.* **W. B. Woodhouse.** (Electrical Times, 22. pp. 818–819, Dec. 4, 1902.)—This is a short paper comparing the Parsons and the de Laval steam turbines, and giving some useful figures in connection with them. [See also Abstracts Nos. 1135 (1900) and 1374 (1901).] R. C. R.

462. *Waste-heat Engines.* **Behrend.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1514–1516, Oct. 4, 1902. Paper read before the Hamburg Bezirksverein, March 18, 1902.)—The author cites a case in which the addition of a waste-heat engine reduced the steam consumption from 5·5 to 3·75 kg. per h.p.-hour. He gives reasons for considering that the available fluids for use in conjunction with a steam plant are confined in practice to SO_2 and NH_3, and briefly reviews various systems which have been tried, concluding that Jorses' arrangement of an SO_2 engine is the most advanced as a working machine. R. C. R.

463. *Management and Working of Steam Boilers.* **W. H. Fowler.** (Mech. Eng. 10. pp. 684–686, Nov. 22; p. 739, Nov. 29; pp. 753–755, Dec. 6, and pp. 803–806, Dec. 13, 1902.)—These articles, which contain numerous illustrations of various types of boilers, deal with the arrangement, working, and equipment of boilers and auxiliary appliances. G. W. DE T.

464. *Fencing of Gas Engines.* **H. D. Marshall.** (Inst. Mech. Engin., Proc. 2. pp. 211–220; Discussion, pp. 248–293, March–May, 1902.)—After a brief review of the usual modern practice in this respect, the author makes a few suggestions with a view to the provision of additional safeguards. G. W. DE T.

465. *Standardisation of Pipe Flanges and Fittings.* **R. E. Atkinson.** (Inst. Mech. Engin., Proc. 2. pp. 303–339; Discussion, pp. 340–371, March–May, 1902.)—The paper contains numerous tables illustrating standards adopted in the United States and in Germany, and also of the standards used by individual firms in this country. Detailed proposals are then sent forth, and illustrated by sectional drawings. G. W. DE T.

466. *Smoke Prevention.* **W. C. Popplewell.** (Feilden, 7. pp. 473–487, Dec., 1902.)

Digitized by Google

INDUSTRIAL ELECTRO-CHEMISTRY AND GENERAL ELECTRICAL ENGINEERING.

467. *Electrolytic Purification Trials at Salford Sewage Works.* **J. Corbett.** (Engineering, 74. pp. 865–866, Dec. 26, 1902. Abstract of paper read before the Sanitary Institute Congress at Manchester. (Sections II. and III.)—Webster's electrolytic process of sewage purification is reported to have been in many points the most successful of the methods tried. Its cost was somewhat high, though by no means the highest considered practicable, and it would have been adopted at Salford but for the inability of the company to finance so large a scheme. The sewage is passed between cast-iron plates, alternately connected with the positive and negative poles of a dynamo. After filtration from the fine particles of oxide of iron the effluent is bright and of good quality, as shown by the average analysis given. About half the cost of working is for power to produce the electricity required; the process might, therefore, be cheap where water-power was available. The requirements per million gallons of sewage treated per day were: steam engine or other power of 41·76 i.h.p.; electric h.p. therefrom, 33·4; average voltage employed, 41·02; iron used from the electrodes, 428 lbs., equal to nearly 3 grains per gallon. A number of different forms of sprinklers were tried for filter-beds; ultimately a jet was adopted by which the liquid was set whirling by passing through inclined holes in the lower part, so that it was thrown out in a very fine spray over a circle of about 12 ft. diameter. These jets, however, were somewhat more difficult to clean than the simpler ones, and showed a tendency to become coated with lime, especially if a large quantity was used as a precipitant. Machinery, filters, &c., are described in detail. S. R.

468. *Purification of the Atmosphere by Ozone.* **E. T. Williams.** (Elect. Rev. 51. pp. 767–768, Nov. 7, 1902.)—The author describes the exhibit at the offices of the Atmospheric Electrical Purification Company, Ltd., Manchester, of an apparatus for ozonising the air of rooms. The air is driven by an ordinary electric fan between two grids (from one to the other of which a brush discharge passes), and thence into the room to be ventilated. The arrangement has been tried at a meeting of the Medical Congress and on the steerage deck of a ship of the Beaver Line. D. H. J.

469. *Treatment of Refractory Zinc Ores and Zinciferous Products.* **Borchers.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1684–1685, Oct. 25, 1902. Paper read before the Aachen Bezirksverein, April 2, 1902.)—This is a continuation of an account already given by Rontschewsky [see Abstract No. 2296 (1900)] with reference to this subject. Zinciferous galena, and also the middlings resulting from the mechanical dressing of such ores, and which cannot be further dealt with by chemical or electromagnetic methods, are among the products which the author proposes to treat by means of electrolytic chlorine in revolving drums at a temperature of 30–40° C. Chloride of the metals present are formed with the elimination of free sulphur. These chlorides are leached systematically by means of water, and after removing the free sulphur from the remaining sludge by fusion with steam under pressure, the residue consists of an easily smelted 40 per cent. zincy product, carrying most

Digitized by Google

of the silver. The mixed solution of chlorides of zinc and lead are boiled down and completely dehydrated, and finally submitted to electrolysis without previous separation. The zinc and lead thus obtained will separate into two layers if kept fused, analogous to the ordinary desilverisation by means of zinc (Parkes process). The electrolysis of the mixed chlorides is particularly advantageous, as ordinary iron vessels can be employed, which cannot be done in the case of $ZnCl_2$ only. The following are the products obtained: Sulphur, chlorination residue of argentiferous zinc blende, silver, lead, and zinc. Zinc blende carrying large quantities of heavy spar may also be advantageously treated by this method. Residues from galvanising works may be converted into the $ZnCl_2$ and mixed with another metallic oxide, for instance CuO, and reduced by calcium carbide by melting, thus yielding brass, or other similar alloys (Kugelgn). Silicious zinc ores, according to Dorsemagen, may be treated in the electrical furnace for free zinc, which distils off, and carborundum, which is formed at the same time. Zinciferous pyrites may be treated in a similar manner, yielding ferro-silicon as a by-product. O. J. S.

470. *Modern Turbine Practice and the Development of Water Powers.* **J. W. Thurso.** (Eng. News, 48. pp. 462–471, Dec 4, 1902.)—The author discusses the principles governing the construction of turbines, and gives detailed descriptions and drawings of various types of turbines in use in connection with power plants in Europe and America. He maintains that, for high heads, the best type of turbine is to be obtained by a combination of the Pelton wheel and the radial free-deviation turbine. G. W. DE T.

471. *The New American Turbine.* **C. Herschel.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1788–1789, Nov. 22, 1902. Remarks by **Pfarr**, pp. 1789–1790.)—In this article Herschel describes and defends the method employed by the Holyhoke Water Power Company for testing the efficiency of "The New American Turbine," and criticises Pfarr's results. [See Abstract No. 44 (1903).] The latter defends his tests, and answers most of the points raised by Herschel, giving also some curves corroborating his statements. L. G.

472. *Machine Shop Driving by Individual Motors.* **R. T. E. Lozier.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1541–1552, Dec., 1902.)—Experience shows that the average loss in belt-driven machine shops is 50 per cent. of the maximum effective h.p. transmitted; if the mean load-factor is taken as 80 per cent., the real efficiency comes out as only 28 per cent. With individual motor-driving, an effective mean 80 h.p. at the machines only requires 48 h.p. to be generated—giving an efficiency of 70 per cent. Thus, on a plant with an output of 1,000,000 dollars yearly, 18,000 dollars per year would be saved by individual driving. Dealing with the question of speed variation of the motors, figures are given which show that if this is properly arranged for, the average power to be provided by the generating plant need only be 10·5 per cent. of the aggregate rated capacity of the motors installed. Provision must of course be made for maximum conditions. Speed control of the motors can be effected: (1) By rheostats, using a fixed pressure. Disadvantages of this method are; possible variation of the speed with a change of load when not desired; inefficiency; and in some cases inconveniently large dimensions of the rheostat. (2) Multi-voltage method with balancers. This method is efficient, convenient, and gives a wide range of speed independent of torque or load on the motor. (3) Special methods, of which the "teaser" system, applied to the printing machines, is an instance.

Digitized by Google

(4) Field control, objections to which are sparking with weak fields, diminished torque, and limited range; further, the speed variation must always be in the direction of an increase over the normal speed. Diagrams are given showing graphically the conditions with the different methods of control. By the multi-voltage and rheostat methods used together speed increments can be obtained as finely divided as is required, with high efficiencies and practical constancy of speed at any one point in spite of varying torque. The paper concludes with a discussion of the advantages accruing to the manufacturer from the use of higher speeds, especially as applied to iron-working machinery, and a comparison of older and more modern practice in this respect. [See also Abstracts Nos. 321 (1900) and 560 (1902).] B. P. S.

473. *Electric Driving in Cement Works.* (Elect. Rev. N.Y. 41. pp. 602–605, Nov. 1, 1902.)—This article describes a power plant of 1,000-kw. capacity installed at the works of the Whitehall Portland Cement Company at Cementon, Pa. All the machines used in this factory are driven by direct-current electric motors which have been in successful operation for two years. The crusher is operated by a 250-h.p. motor which runs continuously day and night. From the crusher the cement passes to the ball mill by means of a motor-driven conveyor. The ball mills are driven by 75-h.p. direct-connected motors running at 215 r.p.m. Motor-driven conveyors carry the cement to motor-driven roasters. The powdered bituminous coal used in the roasters is crushed in a mill driven by a 75-h.p. motor, and is blown in by means of blowers driven by 100-h.p. electric motors. From the roasters, the clinker is carried by motor-driven conveyors to the cooler, and from thence back through the ball mills, where it is reground, and placed in bags for shipment. G. W. DE T.

474. *Electrically-operated Turntables.* (Mech. Eng. 10. p. 707, Nov. 22, 1902.)—This is an abstract of a report of a Committee appointed by the American Association of Railway Superintendents of Bridges and Buildings to inquire into the subject. They report that an ordinary railway motor and controller is suitable for this work. It should drive the turntable through double reduction gearing, which should be enclosed. A tramway motor, rated at 20 h.p. and capable of giving 7 h.p. continuously, is of about the size ordinarily required. The actual power required to turn a 60-ft. table, carrying an engine weighing 200,000 lbs., at the rate of one revolution in 40 seconds, varied in one case from 8 h.p. to 12 h.p., depending on the position of the engine. At starting the load was much greater. With electrically-operated turntables no time need be lost in balancing the locomotive; in the above-quoted case the minimum power seemed to be required when the engine was slightly out of balance. The best method of conducting the current to the motor is to bring the wires up through the central casting of the turntable to stationary collector-rings. Other methods are also mentioned. W. H. S.

475. *Electrically-driven Centrifugal Machines.* (Engineering, 74. pp. 802, 803, and 808, Dec. 19, 1902.)—This article contains a description and drawings of the mechanical details of electrically-driven centrifugal machines, as constructed by Pott, Cassels, & Williamson, of Motherwell. The motor is mounted on a hollow shaft, through which the spindle of the centrifugal machine passes. The motor is connected to the work by means of a clutch, which is fitted with a number of sliding arms, provided at their outer ends

Digitized by Google

with friction pads. As the speed increases the sliding arms are driven outwards by the centrifugal force, thus closing the clutch and setting the machine in motion. It is said to be unnecessary to provide starting resistances with this form of machine. W. H. S.

476. *Electric Crane.* (Zeitschr. Vereines Deutsch. Ing. 46. pp. 968–970, June 28, 1902.)—The crane here described has a span of 43·3 m., and lifts 5 tons at the rate of 26 m. per minute, the cross-travel being at the rate of 120 m. per minute. The crane, which consists of lattice girder work, is carried by end columns, similarly constructed, and can be moved longitudinally at the rate of 200 m. per minute. Drawings are given showing some of the details of construction. The lifting is effected by a 85-h.p. polyphase motor, working at 50 cycles, 400 volts, and 960 r.p.m.; the crab is moved by a 9-h.p. motor, running at 1,440 r.p.m.; and the longitudinal travel is effected by two motors of 35 h.p., one on either side of the track, which drive the wheels supporting the crane through double reduction gearing. The two last-mentioned motors are also interconnected by means of bevel gearing and shafting, which passes overhead from one side of the track to the other; in this way inequalities in motion are prevented. W. H. S.

477. *The Ilgner-Siemens and Halske Winding-gear for Mines.* (Elektrotechn. Zeitschr. 23. pp. 961–967, Oct. 30, 1902.)—In this arrangement a multiphase-current from a central station or elsewhere drives a motor coupled direct to the armature of a continuous-current dynamo, the connecting shaft being provided with a heavy flywheel. The continuous current from this dynamo drives a motor which is coupled direct to the winding drums. By this means energy is stored up in the flywheel, and is available for starting the cage. The paper includes two examples of this system—one as applied to an ordinary winding drum, and another as applied to the Koepe system of winding (*i.e.*, where two cages are employed, one at each end of the rope). A number of drawings to scale are given in the original paper. C. K. F.

478. *Electric Bell Systems in the Navy.* (Elect. Rev. 51. p. 842, Nov. 14, 1902.) —This article first gives a description of a form of electric trembler bell suitable for use at sea, in which the electromagnet cores each extend at one end out of a watertight casing, where they coact with a vibrating armature bearing the hammer, their inner ends coacting with a second vibrating armature bearing the contact-breaker. The paper also comprises a description of various systems of wiring whereby "reply" or return signals can be given, and comprising the "group" system, in which each group of stations has its own battery and return. Here a four-core cable is necessary at each station; these are run from a terminal box at the central, where the battery for the particular group is located. Of the four cores, two go to the distant bell from the home push, including the battery in the circuit at the terminal box, and two come from the distant push, including the battery in the same way at the terminal box and running in, one straight to the home bell and one through the indicator, and so to the other terminal of the bell. C. K. F.

479. *Electrically-operated Coal Hoist.* **P. O. Keilholtz.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1565–1568; Discussion, pp. 1592–1604, Dec., 1902.)—An electric hoist is more costly than one worked by steam, but costs less in operation and in maintenance. The full power can be applied longer

Digitized by Google

in the former case than in the latter owing to the smaller inertia. In lowering the empty shovel with a steam drive, the motion has to be controlled by brakes; the heat generated by the brakes is serious, and the amount of friction is uncertain. With an electric system, the motor during lowering is driven as a generator by the weight of the descending bucket, and the current generated by the armature is passed through a rheostat, and the heat is thus easily dissipated. The author describes in outline a certain coal hoist, giving a sketch of the hoisting tower, a wiring diagram, a distance-time curve, and other particulars. The coal is lifted by this hoist at the rate of 70 tons an hour, and the efficiency was found to be 58·5 per cent. The average load of coal was about 1 ton, and the average velocity was 8·4 ft. per second. The Ward-Leonard system of control is used. The equipment includes a motor generator supplying current to the hoist motor. The field of the generator is separately excited, and its strength is controlled by the operator by means of a rheostat, operated by foot. The motor, driving the generator, is supplied with 550-volt direct current, as is also the field of the hoist motor. W. H. S.

REFERENCES.

480. *The Storage Battery as a Factor in Speed Control.* **H. B. Coho.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1561–1564; Discussion, pp. 1592–1604, Dec., 1902.)—Some notes on the applicability of accumulators to the driving of printing presses, and to other cases in which a variable speed is obtained by a variation of voltage. W. H. S.

481. *Conversion of Amorphous Carbon to Graphite.* **F. J. FitzGerald.** (Frank. Inst., Journ. 154. pp. 321–348, Nov., 1902.)—This is an historical account of the subject by the chemist of the International Acheson Graphite Company. D. H. J.

482. *Electrolytic Manufacture of Chlorates.* **J. B. C. Kershaw.** (Elect. Rev. N.Y. 41. pp. 435–437, Oct. 4, and pp. 475–480, Oct. 11, 1902.)—These two papers give a well-illustrated historical and descriptive account of the manufacture of chlorates by the electrolysis of warm solutions of chlorides. D. H. J.

483. *Meters for Three-phase Systems with Four Wires.* (Elekt. Runds. 20. pp. 1–2, Oct. 1, 1902)—The author deduces formulæ for the power in a three-phase system in which the neutral points are connected by a return conductor, and describes how these formulæ have been applied by the Union Company of Berlin to the construction of meters working on the Ferraris principle. [See Abstract No. 350 (1903).] A. H.

484. *Electric Cranes at Emden Harbour.* **H. Langner.** (Elektrotechn. Zeitschr. 23. pp. 879–884, Oct. 2, and pp. 902–905, Oct. 9, 1902.)—These include fifteen 3-ton cranes, one 10-ton crane, one of 40 tons, and a coal-tip capable of dealing with a maximum load of 15 tons and of emptying 12 trucks in an hour. They were constructed by Siemens and Halske, and the details of construction are fully described. W. H. S.

485. *Cranes at the Harbour on the Rhine, Karlsruhe.* **F. Winawer** and **C. Bender.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1801–1808, Nov. 29, 1902.)—Various dock cranes are here described, and drawings are given showing general design and some of the details of construction. W. H. S.

Digitized by Google

GENERATORS, MOTORS, AND TRANSFORMERS.

486. *Armature Interference and Brush Position.* **H. M. Hobart.** (Elect. Rev. 50. pp. 329–331, Feb. 28; 450–451, March 14, and pp. 455–457, March 21, 1902.)—The author gives a number of tables and curves showing the effect of different brush leads on the ampere-turns required at full load, and suggestions for further experiments. A four-pole 17-kw. 110-volt generator running at 700 revs. with 2½ segments forward brush lead required 42 per cent. increase in excitation to maintain constant voltage at full load, and with two segments backward lead, 15 per cent. increase was sufficient. He is in favour of abandoning all reliance on the magnetic field for overcoming the reactance voltage in the short-circuited coil, relying merely on so designing the machine that the reactance voltage is so low as to exert no harmful influence whatever. He believes that it is possible to design a machine with backward lead so that the armature magneto-motive force shall supply, wholly or in part, the desired compounding or over-compounding, without any special features, such as pole-face windings, commutating coils or reversing lugs. The armature and commutator should be short, of large diameter, with high magnetic flux and current density, and the conductors of stranded copper at or near the armature surface. R. B. R.

487. *Sparkless Commutation.* **P. Prenzlin.** (Elektrotechn. Zeitschr. 28. pp. 933–936, Oct. 23, and pp. 958–961, Oct. 30, 1902.)—The author explains in detail how to calculate the self and mutual inductances of an armature coil, and applies the values so obtained to the determination of the current-wave in the short-circuited coil during the period of reversal. This is done by superposing on the straight-line current wave corresponding to zero inductance the wave of induced current. The brushes are assumed to have no lead. The variation of the brush contact resistance is next discussed. The author gives the results of experiments which go to show that the resistance per sq. cm. of a carbon brush contact is, for a given pressure and current density, independent of the resistivity of the carbon composing the brush, and independent of the velocity of rotation. The width of the brush should never exceed that of two segments; the evil effects of brushes of excessive width are readily shown by experiment. The use of high-resistance connectors between the armature winding and the commutator produces unfavourable results, except in cases where the harmful effect of the external magnetic field is considerable. The effect due to this field is considered in the last section of the paper. A. H.

488. *Commutation.* **H. St. Hill Mawdsley.** (Elect. Rev. 51. pp. 930–931, Dec. 5, 1902.)—The author describes two methods of utilising the increased magnetic potential at the leading pole-tip. In one method a small extra core is added between the main armature core and the commutator. Wrought-iron strips are bolted on to the leading pole-tips and carried round to the trailing pole-tips to form poles over the extra core. In the other method connecting bonds of iron or steel connect the pole-tips, the bonds being separated from the pole-shoe proper by about ¼ in. air space, so that the armature current does not influence the flux in the bonds. The magnetic

Digitized by Google

potential at the leading pole-tip being greater than that at the trailing, lines of force will flow through the bonds tending to equalise the flux over the pole-shoe, thus increasing the induction at the trailing tip. R. B. R.

489. *Loppé's System of Compounding Dynamos for Train-Lighting.* **P. Letheule.** (Elect. World and Engineer, 40. pp. 999–1000, Dec. 20, 1902.)—The method employed is described in Abstract No. 411 (1903). It is here pointed out that the loss in excitation is great, and the number of ampere-turns necessary is also considerable, if the voltage is to be kept reasonably constant. Thus, if the voltage is not to be allowed to increase more than 10 per cent., the ampere-turns of separate excitation must be eleven times more than the ampere-turns which would give the same voltage if unopposed, and the shunt ampere-turns have to be ten times greater than necessary. The author adds the results of some tests he has made with a machine not built for the special purpose. It was intended to give 10 amperes at 107 volts and 1,500 r.p.m. The shunt coils having been suitably connected up on the above system, the voltage varied from 18 at 2,000 r.p.m. to 20 at 3,000 r.p.m., when run under load. In conclusion, various diagrams are given showing possible combinations of dynamo, battery and separate exciter. W. H. S.

490. *Design of Polyphase Machines.* **D. Bergman.** (Elect. Rev. 51. pp. 1056–1057, Dec. 26, 1902.)—The author contrasts current Continental with American practice. A high power-factor in induction motors may be obtained by: (*a*) Distributing the windings in a large number of slots; (*b*) making the armature diameter large, and the length of core small; (*c*) reducing the number of conductors and simultaneously keeping the no-load current small. In order to fulfil this latter condition, nearly closed slots are used by Continental makers; this increases the cost of manufacture. American makers, on the other hand, prefer to use open slots, and keep down the no-load current by using more iron in the motor. A Continental 15-h.p. three-phase induction motor would have a power-factor of 0·90 and an efficiency of 86 per cent. (at full load); an American motor of the same output a power-factor of 0·92 and an efficiency of 82 per cent. Dealing next with generators, the author favours the rotating armature type as against the revolving field type. A. H.

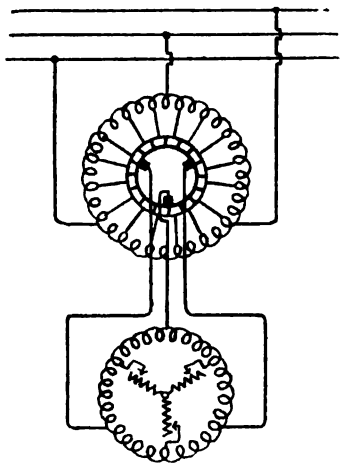
491. *Differentially Compounded Motor.* **W. R. Kelsey.** (Elect. Engin. 30. pp. 887–889, Dec. 12, 1902.)—Motors with a differential compound winding are required in exceptional cases only, the shunt-winding giving a sufficiently constant speed under ordinary circumstances. Such an exceptional case arises in connection with motors used for driving textile machinery. The author gives a detailed account of a method for calculating the series and shunt-turns required to maintain the speed constant between given limits of load. He concludes that a differentially-wound motor has good speed regulation, but is heavy and expensive in cost and working. Its speed should be high and its resistance low. A. H.

492. *Single-phase Rotary Converters.* **A. Banti.** (Elettricista, Rome, 11. pp. 257–261, Nov., 1902.)—For the Rome tramways, single-phase rotary converters of 60 kw. are used to charge accumulators. It was found that, while by proper regulation of the excitation the power-factor on the alternating-current side was nearly unity, the continuous-current side showed a discrepancy between the true power and the product of volts and amperes,

Digitized by Google

the power-factor being nearly constant at 0·86 for all loads. With a non-inductive [?] resistance for the load, the power-factor improved to 0·92–0·97. The variations in the current could be detected by putting an induction coil in the circuit, and they could be directly observed by a suitable optical device. By putting a self-induction in series with the accumulators the power-factor could be brought up nearly to unity, though, when the self-induction was too great, the converter fell out of step. A. E. L.

493. *Phase Compensation for Induction Motors.* **M. Osnos.** (Elektrotechn. Zeitschr. 28. pp. 919–921, Oct. 16, 1902.)—After a brief reference to the induction motors devised by Görges, Heyland, and Latour [see Abstract No. 2475 (1901)], the author describes the method invented by himself and shown in the accompanying sketch for improving the power-factor of induction motors. The diagram refers to a 2-pole motor. The primary winding



is provided with a commutator, and against this press three brushes 120° apart. These brushes are mounted on the rotor, and are connected to three points of the rotor winding 120° apart. If three-phase currents are fed into the stator, a rotating magnetic field is produced; assuming the brushes to be driven at synchronous speed, a constant continuous p.d. would be obtained across any pair; but if there is slip, the brush p.d. will become an alternating one, and it is evident that its frequency will be the slip frequency. Thus the rotor windings will be supplied with currents of frequency always equal to the slip frequency. In order to provide closed paths independently of the brushes for the currents induced in the rotor windings by the slip, three points are selected symmetrically placed with respect to the points of connection of the brushes, and these are connected to a common point through resistances used at starting and subsequently short-circuited. A. H.

REFERENCE.

494. *Diagram of General Alternating Current Transformer.* **F. Eichberg.** (Zeitschr. Elektrotechn., Wien, 20. pp. 485–489, Oct. 5, 1902.)—The author discusses critically the connection between the various diagrams proposed for the transformer. The paper does not admit of a useful abstract. A. H.

Digitized by Google

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

495. *Substation Plant for High-Tension Polyphase Supply.* **A. Mossay.** (Assoc. Ing. Él. Liège, Bull. 2. pp. 345–361, Nov., 1902.)—When the pressure of the supply does not exceed the practical limits for which polyphase motors are constructed, three systems are possible : (1) Induction motors and direct-current generators; (2) synchronous motors and direct-current generators; (3) static transformers and rotaries. A fourth may be added, not yet sufficiently tried in practice, the use, namely, of Leblanc's "panchahuteur" [see Abstracts Nos. 856 (1900), 789 and 790 (1902).] The first is reliable and easy to work, even for pressures as high as 10,000 volts; induction motor-generators are suitable for high frequencies, tend to steady the load on the mains if there is any tendency to oscillation in the supply, start with small current, and are capable of heavy overload. The principal objection is the low power-factor. The second system is of limited application; the chief advantage is the compensating effect of the synchronous motors as regards the wattless current on circuits supplying induction motors. The starting is difficult, the initial torque is bad, and they are liable to fall out of phase, especially if the frequency is somewhat high. The third system has the advantages of the synchronous motor, and by the combination of alternating motor and direct-current generator presents advantages in one machine over either of the other systems. The heating of the machines is small, the output high, commutation is sparkless, and the pressure under perfect control; against this, the slip increases with the excitation and with the load, and, therefore, there must be regulation not only for ohmic drop, but also for drop in speed. Any liability to hunting can be overcome by the use of *amortisseurs*, or by employing six-phase connection. A table is given of careful tests made on an induction motor-direct current generator set of 350 kw., an asynchronous motor-direct current generator set of 230 kw., and two transformer-rotary sets of 250 and 500 kw. respectively, showing efficiencies, power-factors, and heating at various loads, and also the total weights of each set. The superiority of the latter type is clearly shown, as it is also in a table which is given of prices per kw. of the three different plants; the figures given for a 800-kw. set are—

Induction motor and d/c generator	46·08	francs per kw.
Synchronous motor and d/c generator ...	41·62	„ „
Transformers and rotary.....	29·625	„ „

Rotaries, on account of their reversibility, may soon be called upon to solve difficulties entailed by the necessity for unifying the supplies in large cities. In Cleveland, *e.g.*, the use of a rotary connecting the alternating and direct-current mains would do away with two 400-kw. generators, one of each type. If batteries are used in the substations, motor-generator sets are very convenient from the facility with which the direct-current pressure can be adjusted either for charging or direct running. If rotaries are employed, the only practical method is to use either variable ratio transformers or boosters.

B. P. S

Digitized by Google

ELECTRICITY WORKS AND TRACTION SYSTEMS.

496. *Electric Power at the Düsseldorf Exhibition.* (Engineering, 74. pp. 768–772, Dec. 12, 1902.)—This article gives a general outline of the system under which electric light and power was supplied at the Exhibition. A diagram is given showing the connections on the main switchboard, the current taken by the various circuits, and the nature of the supply. From this diagram a good idea can be obtained of the scale on which the Exhibition was planned. A list is also given of the engines and generators which supplied power, and short information is given about each in tabular form. The engines were mostly of the slow-speed type, ranging from 72 r.p.m. upwards, and a few were coupled to the electric generator by belt or rope; the list also included a Laval turbine, running at 18,500 r.p.m., direct-coupled to a small dynamo. Power was supplied on the three-phase system, either at 2,000 or 5,000 volts; on the three-wire continuous-current system either at twice 115 or twice 220 volts; and a portion of the grounds was lighted by single-phase alternate current. The price charged was 8·4d. per unit for light, and 3·6d. per unit for power, with discounts ranging up to 25 per cent. Power was supplied to 40,000 incandescent lamps, 1,200 arc lamps, and 600 motors, the latter amounting in all to 5,200 h.p. The maximum load on the generators was 6,500 e.h.p. W. H. S.

497. *New Electric Plant at Brussels.* **A. della Riccia.** (Soc. Belge Élect., Bull. 19. pp. 666–689, Nov., 1902.)—This paper begins with some statistics relative to the supply of current at Brussels. There are 340 km. of cable laid down, supplying the equivalent of 142,000 16-c.p. lamps. Mains are laid in 63 km. of streets—in some of the principal streets on both sides. The mean load is at the beginning of April and October, the minimum (53 per cent. of the mean) about July 15th, and the maximum (about 132 per cent. of the mean) about the middle of December. There were at the beginning of 1902 three supply stations, with a total output of 4,330 kw., supplying direct current at 110 and 220 volts. As the mains were rapidly becoming overloaded, large extensions became necessary, and it was decided to build a large new station outside the city, and in the meantime to put down new machinery of the most modern type in the existing stations, which could afterwards be utilised in the new station. The new plant included an alternator of 675-kw. capacity, which was installed in one of the existing stations, and of six transformer-generator sets each of 375 kw., at 250 volts on the direct-current side, and 5,000 volts, three-phase, on the alternating.

Full data are given of the construction and electrical and magnetic constants of the machines. The losses, not only in the moving plant but in the switchboard connections, &c., are stated, with the total efficiencies at different loads. A full description of the switchboards follows, and the author concludes with descriptions of the method of synchronising and of an automatic oil switch largely employed in the installations. The plant was supplied by the Société Anonyme l'Union Électrique Procédés Thomson-Houston. The paper is illustrated by photo-blocks and diagrams.

B. P. S.

498. *Maidenhead Electricity Supply Works.* (Elect. Engin. 30. pp. 870–875, Dec. 19, 1902.)—System: Three-wire continuous current with a pressure of 460 volts across the outers and 230 volts at the lamps. The boiler-room contains two Babcock and Wilcox water-tube boilers set in one battery, each

Digitized by Google

having 1,619 sq. ft. heating surface and working at 160 lbs. per sq. in. pressure. The feed-water is treated in a water softener (Oscar Guttmann patent) capable of dealing with 1,500 gallons of water per hour, which is fully described. Coal is stored in a bunker on the stoking floor into which it is tipped direct from carts from an inclined roadway, and is fired by hand. The engine-room contains three steam dynamos, of which each engine consists of a vertical high-speed 95-i.h.p. engine running at 500 r.p.m. The engines are two-crank compound self-lubricating with cylinders 8 in. and 15½ in. by 6 in. stroke. Each engine drives direct a 60-kw. multipolar continuous-current dynamo with a terminal pressure of 460 to 500 volts. They are shunt and compound wound for lighting and traction respectively. There are boosters for regulation purposes. Feeders, of the Callender Cable Company's manufacture, consist of triple concentric cables insulated with paper and sheathed with solid vulcanised bitumen in place of lead. They are drawn into Sykes' patent jointed conduits. The feeders have a sectional area of 0·10, 0·05, 0·10. Distributors of the same type consist of 2 miles of 0·10, 0·05, 0·10 sq. in. sectional area and 2 miles of 0·08, 0·04, 0·08. The arc-lamp circuit consists of 0·022 single conductor insulated with vulcanised bitumen, 10 lamps being connected in series across the outers. The station is equipped with two batteries of Hart Accumulator Company's accumulators, each of 128 cells of 35 amperes for 10 hours or 70 amperes for 5 hours' capacity with maximum discharge of 100 amperes. The equivalent of 4,000 8-c.p. lamps is connected. The price charged is sixpence per unit for lighting and threepence per unit for power, with a rebate of 1 per cent. per 1,000 units consumed per quarter. Maximum demand system is under consideration. A tramway system is also contemplated, and the station has been equipped with a view to this. J. L. F. V.

499. *Power Transmission at Otonabee River, Canada.* (Canad. Elect. News, 12. pp. 204–206, Dec., 1902.)—Power is transmitted 5 miles from the river to Peterboro, at 6,600 volts three-phase, 60 cycles per second. The generating plant consists of three 68-in. Sampson turbines running at 86 r.p.m. and all geared to one shaft, to which the generator is coupled. The latter is rated at 1,200 kw., and runs at 200 r.p.m.; it is of the revolving field type, built by the Canadian General Electric Company. The exciter is of 30-kw. output, and is driven by a 28-in. turbine. The head of water is 18 ft. A Lombard governor controls the speed of the large turbines, while the exciter is regulated by hand. The switchboard is equipped with oil-break switches. There are two overhead circuits to Peterboro, carried on poles, and consisting of No. 2 copper wires on porcelain insulators, with an earthed barbed wire above them and telephone lines below. In Peterboro there is a substation equipped with the necessary switchgear and six 250-kw. air-blast transformers. There is a good demand for power, and a duplicate plant will soon be required. A. H. A.

500. *Large Electric Heating and Lighting Plant.* (Eng. Record, 46. pp. 590–592, Dec. 20, 1902.)—Details are given of the wiring of the Carnegie Residence, New York, U.S.A., in which an unusually large number of lamps are installed, and electric heating apparatus is used to an almost unprecedented extent. Automatic electric elevators are provided, as well as luggage lifts and dumb waiters, and all the pumps and fans in the building are driven by motors. Most of the laundry apparatus and part of the cooking appliances, as well as a variety of stoves, boilers, &c., are electrically heated. A. H. A.

Digitized by Google

501. *Columbus (Ohio) Electric Railway.* **O. M. Carter.** (West. Electn. 31. pp. 457–458, Dec. 27, 1902.)—The railway serves a population of 250,000, and connects Columbus with Hebron, Newark, and the Buckeye Lake, comprising 41 miles of single track. The track in Columbus is laid with 107-lb. girder rails, and in Newark with 90-lb. rails; in the country the track is laid with 70-lb. T-rails on sleepers and ballasted in accordance with steam railway practice. Except in the towns the trolley wire is carried by brackets on wooden poles; in towns the span wire system is used. The trolley wire and two feeders carried on the same poles are of No. 0000 copper wire. Power is transmitted from Hebron 20 miles towards Columbus on the three-phase system. The power station contains two 800-kw. three-phase generators driven by horizontal Corliss engines at 75 r.p.m., two 300-kw. rotary converters, six 110-kw. step-up transformers, and the necessary switchgear and auxiliaries. The substation contains a similar transforming and converting plant, all of the General Electric Company's make. There are sixteen passenger cars, each equipped with two or four 75 h.p. motors and controllers, except two which are used as trailers. Considerable extensions are in hand. The fares are about 0·75d. per mile. A. H. A.

502. *Sydney (Australia) Electric Tramways.* **F. G. Sykes.** (Elect. World and Engineer, 40. pp. 889–893, Dec. 6, 1902.)—The original power station at Ultimo contained fourteen boilers and four 850-kw. generators driven by horizontal compound engines, and was built in 1898. It was almost immediately fully loaded, and a new station was erected from which power is transmitted at high pressure to substations. The boiler-house in the new building is in two floors, each 176 ft. by 84 ft., with two steel coal bunkers holding 2,500 tons of coal above them, and there are two chimneys 224 ft. high. The engine-room is 176 ft. by 96 ft., and is provided with a 30-ton electric traveller. There are 32 Babcock & Wilcox boilers, each having a heating surface of 2,852 sq. ft. and working at 160 lb. per sq. in.; they are fitted with chain grate stokers, fed with coal from the bunkers by gravity, and bucket conveyors are provided for handling the coal and ashes. Three Worthington feed-pumps and two Goubert feed-water heaters are installed, the latter receiving the exhaust steam from the auxiliaries. The engine-room contains three generating sets, with room for three more. The engines are Allis-Chalmers vertical cross compound condensing engines, with cylinders 32 and 64 in. in diameter and a stroke of 60 in., and run at 75 r.p.m. A Worthington surface-condenser is provided for each engine, with air and circulating pumps of the same make; salt water is used for condensing. Each engine drives a 1,500-kw. three-phase generator built by the General Electric Company (U.S.A.), giving 6,600 volts at 25 cycles per second; the armature is stationary, in four parts, with an internal diameter of 280 in., and the field magnet system has 40 poles. For excitation there are two 100-kw. steam dynamos with separate condensers. The switchboard consists of marble panels, carrying only low-pressure apparatus, and designed to control three exciters, six alternators, and five substation feeders. Oil switches are used in the high-pressure circuits. The cables are paper insulated and lead covered, made by the British Insulated Wire Company, and laid in wooden troughs on the solid system. One of the cables, which is laid under the sea in the harbour, is armoured in addition. Wirt lightning arresters are provided at both ends of the cables. There are five substations, each of which, with one exception, contains two 450-kw. rotary converters, running at 500 r.p.m. and provided with induction motors for starting, two

Digitized by Google

sets of three 175-kw. transformers with air blast for cooling, high- and low-pressure switchboards and two storage batteries by the Accumulatoren-Fabrik A.-G. of 500 ampere-hours capacity each, with differentially-wound motor-boosters to regulate charge and discharge. One substation contains only half this equipment. The tramway system comprises 145 miles of track with 526 cars. The track is laid with 83-lb. rails on a concrete foundation, and the overhead equipment includes both centre pole and span wire construction. The cars are fitted with Peckham and Brill trucks and Christensen air brakes. [See also Abstract No. 459 (1901)]. A. H. A.

503. *The Great Orme Tramways.* (Tram. Rly. World, 12. pp. 498–501, Oct., 1902.)—The main features of this new line of tramways are the steep gradients and sharp curves, the average rise being 1 in 6, and the minimum radius of the curves 75 ft. The bed structure is of ordinary railway formation with stone pitching. Concrete is used for the conduit, the thickness varying with the character of the road. The upper part of the conduit is finished with steel "Z" rails, leaving a steel face 6 in. deep on each side and a slot of 1¼ in. wide in the centre. The track rails are of the Vignoles type and have a base 3½ in. wide. The head of the rail is 2 in. wide, and the rail over all is 4 in. deep. The rails are in lengths of 30 ft. and weigh 50 lbs. to the yard. The slot rails are of ½ in. steel with 6 in. web plate, and with angle plates of 3 in. and 3½ in., and weigh 60 lb. per yard. In the lower length of the line the rope is supported in the conduit on grooved steel sheaves 12 in. in diameter, and is guided by vertical steel curve pulleys. At the curves the guiding pulleys are 6 ft. apart. The upper length of line is constructed on the ordinary cross-sleeper plan used for railways, there being no conduit. The ropes are of plough steel, each being half a mile in length, the rope of the tramway being 1¼ in. in diameter and having a breaking strain of 60 tons, and that of the tramroad ⅞ in. in diameter, and having a breaking strain of 40 tons. The power-house contains duplicate sets of engines, winding-drums, and boilers. The engines, by Musker, Liverpool, are of 60 h.p. and 80 h.p. respectively, are horizontal, with two to each set, and are fitted with reversing gear. The set for working the tramway rope has cylinders 12 in. in diameter, and with a stroke of 14 in. The set for the tramroad has cylinders 12 in. in diameter, and with a stroke of 12 in. All cylinders will, for the time, exhaust to the atmosphere. Connection between the engines and the drums is formed by means of helical toothed wheels, the pinion on the engine crank-shaft making four revolutions to one of the spur on the shaft carrying the drum. The passenger cars are mounted on two four-wheel bogies, and each bogie is provided with wheel-brakes, slipper-brakes, and an automatic emergency brake. The wheels are of cast steel 21 in. in diameter by 3¾ in. wide, and the axles of mild steel 3¾ in. in diameter at the centre. A system of telephonic signalling between the drivers of the cars and the engine-drivers at the power-house has been adopted, each car being provided with a Hunnings-conte transmitter and a receiver inside, the passenger cars having a trolley pole at each end which maintains constant contact with the telephone wire. A goods as well as a passenger traffic is worked, a special car mounted on a single four-wheel truck being used for the former. C. E. A.

Digitized by Google

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

504. *Electricity on Railroads.* **E. Fränkel.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1557–1558; Discussion, pp. 1558–1559, Oct. 11, 1902. Paper read before the Berlin Section of the Association of German Engineers, April 2, 1902.)—The author considers that the following are disadvantages of an electrical system, viz., an easily damaged transmission line, difficulties of collection of current, and the heavy loads of the motors on the axles. These disadvantages become more serious with increased speed. He also considers that electrical power is more costly than steam, seeing that transmission and transformation losses may amount to 40 per cent. A poor load factor also operates to the disadvantage of a central power station. He thinks that electricity might be more profitably employed on branch lines, or in country districts. In such cases the steam locomotive is at a disadvantage. Electricity might, on the other hand, be cheaply and profitably supplied by some station which distributed for general purposes in the neighbourhood. If, in country districts, power were to be supplied for railway purposes from local sources, a great impetus would be given to the establishment of such power stations, which would be of great value locally; and, moreover, this would be likely to result in a standardisation of plant, voltages, periodicity, &c.

W. H. S.

505. *Track Construction of Suburban and Interurban Electric Railways.* **S. S. Hoff.** (Street Rly. Rev. 12. pp. 588–590, Sept., 1902. Paper read at the Annual Meeting of the Pennsylvania Street Railway Association, Sept. 10, 1902.)—In projecting a roadway for this purpose it is frequently advisable to make minor changes in the original roadway in order to avoid many small "kinks" in surface and line; these changes may slightly increase the first cost, but in the end are justifiable. It is advisable to keep away from bottom lands in the vicinity of long tortuous water-courses and territory of rapid watersheds, as in such localities it is necessary to erect many bridges, material for embankments is very scarce, and the roadbed is constantly in danger of wash from high water and sudden downpours of rain forming rapid and uncontrollable floods. Long straight lines or tangents are with many the great desideratum, and frequently to gain this end sharp curves are resorted to, whereas by the introduction of some additional lighter ones those with very short radii might often be avoided. The slopes of cuts and embankments should be made sufficiently flat to resist the erosive effects of the elements. All foundations should be made of concrete and ample time should be given for the cement to set and harden before building upon it. Pipe drains should never be less than 12 in. diameter. All roadbeds should be so constructed as to admit of placing 6 in. of clean gravel or broken stone ballast under the ties for the promotion of sub-drainage and for tamping the ties to a firm and elastic bearing, from the ends to about 10 or 12 in. inside the rail bearings, the middle of the tie remaining untamped. The ties should be placed 2 ft. apart between centres; they should have a top and bottom face of 8 in. and be not less than 7, preferably 8 ft. long. The rails should be as heavy as possible. The weight of new rolling stock, according to present practice, never lessens after a road has been put into operation, and it is very difficult to keep a track in even fair surface or line when the rails begin to depress

[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

Digitized by Google

between the tie bearings. Special work should be the best obtainable, long radii being always used on the switch ends in preference to the quick jerky short leads and points so often seen, and the best efforts should be put forth in securing dry and uniformly firm beds throughout the full length of the frog and switch pieces to eliminate as much as possible the tendency to wear in spots. In order to maintain the proper gauge with girder rail construction, the rails should be braced at about every fourth tie with outside pressed steel braces. Concealed joint bonding is the best for a track, as it is the least liable to be loosened by vibration or careless interference by trackmen. All tracks in cities should be paved inside and outside the rails to the limits of the ties, and this paving should consist of a material and be so shaped as to shed water rapidly in order to prevent it seeping through the ties. C. E. A.

506. *The Schuler Rail-Joint.* (Engineering, 74. p. 587, Oct. 31, 1902.)—It is claimed for this type of rail-joint, which is used largely on the Swiss, German, and Swedish railways, that it is free from all the defects and disadvantages which are inherent to other rail-joints ; that it prevents all shifting of the rail-joints one with regard to the other, and does away with the hammering by reason of its elasticity. The angle fish-plates are of a special section, made with a vertical extension, which comes directly underneath the joint, and serves to support the two rail-ends by means of wedges. Owing to the large total bearing surface of the fish-plates against the rails, the latter cannot get deformed and the rail-level at the joints can be regulated by the wedges. It is claimed, however, that the device requires no resetting, the wear and tear at the joints being practically nil, owing to the elasticity of the system. C. E. A.

507. *A Series-Parallel System of Speed Control.* **G. W. Fowler.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1569–1579 ; Discussion pp. 1592–1604, Dec., 1902.)—This is a description of the parts of a system, including a double commutator motor, switchboard controller, automatic switches, and emergency switches. The motor is of the slow speed type with two separate windings and commutators on the one armature body, both operating in one magnetic field. Field windings arranged for cutting out of series turns after starting, thus obtaining a powerful starting torque with a minimum of current, and a constant speed when the motor reaches a fixed speed, both features of compound and shunt-wound motors. The method has been adopted for the control of motors operating printing presses, or other classes of machinery where a very wide range of speed is required. The controller comprises a number of contacts in circular form, divided into two groups, right and left hand. The right set are of large section and in use when the armature windings are in parallel. The left set are smaller in section and also more in number, for use when the windings are in series. A central pivot carries a contact arm which sweeps over the contacts and also carries a smaller brush engaging with two rings and a series of contact studs. These are used to insert resistance in the shunt-field of the motor, for the highest speeds. To graduate the speed of the motor two resistances are employed—one in circuit with the armature windings when in series, and the other connected with the armatures when in parallel. The change from series to parallel control is carried out without arcing at the contacts or magnetic blow-out coils, a special solenoid switch being employed for the purpose. This consists of two electromagnets fixed horizontally at the back of a slate slab and having a core sliding through their centre. This carries a pivot to which a lever is attached,

Digitized by Google

and from this the switch itself is operated, on the front of the slab. To prevent arcing when switching "on" and "off," a solenoid operated switch is used which is not closed or opened until the controller is in the "off" or "on" positions. This same switch can also be actuated from any distant point, should it be necessary, such as in printing operations. The cycle of control begins with the placing of the armatures in series with all resistance in circuit; successive movement cuts out all the resistance as well as the series field, leaving the motor running as a shunt-wound machine with armature windings in series. Further movement puts the windings in parallel, with just enough resistance in circuit to keep speed and current normal; this is then cut out by a continued movement of the lever. Five more speeds are still obtainable by inserting resistance in the shunt field. Comparisons with a double commutator machine operating a Hoe Quadruple Press, indicated that the current required to exert the maximum torque when starting from rest was less than that required by a single compound wound motor with rheostat control, for the same operation, while the efficiency at all speeds was much better. W. E. W.

508. *Grampe's Fender for Electric Cars.* **A. Seyfferth.** (Elektrotechn. Zeitschr. 23. pp. 986–989, Oct. 23, 1902.)—In this arrangement there is a lattice buffer-screen, which is arranged along the front of the car, and is supported on spring-pressed plungers at its lower edge. These plungers are connected together by a transverse bar bearing a detent, which controls a spring-actuated series of levers, connected to a pivotally-mounted fender arranged beneath the car in front of the wheels, this fender having its lower edge normally out of contact with the ground. When, however, the buffer-screen is pressed back by contact with any person, the detent will be tripped, and the fender caused by its actuating springs to swing down and bring its lower edge into contact with the ground. At the same time a switch, which has its actuating arm coupled to the fender, cuts off the current from the motors driving the car, and then short-circuits them so as to produce a powerful braking effect on the car; a track-sanding device can also be actuated by this motion. In addition to the buffer-screen above mentioned, the detent can be also tripped by means of an apron or lattice-frame hanging from the lower edge of the buffer-screen. This apron has upwardly extending lever arms, which are connected by chains to the car. By this means, in the event of the lower part of the apron striking a person lying on the ground, the apron will swing about the ends of its lever-arms and push inwards its axis of suspension, *i.e.*, the lower edge of the buffer-screen, and with it the plungers, so that the detent will be tripped and the fender released in the same manner as that above described for the buffer-screen.
C. K. F.

509. *Electric Traction on Canals.* **L. Gérard.** (Soc. Belge Élect., Bull. 19. pp. 609–688, Oct., 1902. Report presented to the International Congress at Düsseldorf, 1902.)—The author finds as the result of his experience during three years on a portion of the canal between Charleroi and Brussels that the use of an ordinary towpath is impracticable. The towpath in question was admittedly in bad condition, the coefficient of traction being 4·5 kg. per ton. The number of units taken per barge-kilometre varied with the time of year, *i.e.*, with the condition of the towpath, between 3·04 in March and 2·24 in October, 1901. The efficiency of the tractors after a year's service is about

Digitized by Google

0·48. Unloaded and travelling at 4 km. per hour, the tractor takes 4·1 kw.; when hauling a barge of 70 tons at the same rate, the power required is 4·85 kw. The wear and tear on the wheels of the tractors, which are of cast Martin steel, is very serious; and the author considers that repairs of all kinds cost three times as much as they do on an ordinary tram line of the same length. The author then proceeds to consider the possibility of using tractors, running on rails on the towpath. It had been supposed that either heavy tractors would be necessary to secure adhesion or that a rack rail would be necessary. Experiments were undertaken on the canal with a view to finding the pull at starting. With a heavy tractor running on the towpath, and a pull falling from 625 kg. to 120 kg., a speed of about 3·5 km. per hour is reached in 50 seconds with a barge of 70 tons; with a tractor weighing 1,650 kg., and giving a steady pull of 264 kg., the same speed would be reached in about 30 seconds. Some experiments which were carried out at Oisquercq under rather unfavourable conditions showed that full speed could be reached in about 45 seconds with a light tractor on rails, and this tends to confirm the result of theoretical calculations. The author therefore advises that rails should be laid on the towpath, and the experiments continued.

W. H. S.

510. *Figure-of-eight Trolley Wire.* **M. Schiemann.** (Elektrotechn. Zeitschr. 28. pp. 842–843, Sept. 18, 1902.)—Trolley wires of figure-of-eight form are being largely used in Germany. The objection that they are liable to twist applies only if their section is unsymmetrical, so that the mechanical suspension ear does not hold them throughout the centre of gravity. With a symmetrical section no trouble from twisting is experienced if care be taken in unrolling the wire from the drums. A special form of suspension insulator, giving a certain degree of freedom in a longitudinal direction, is described, as well as a method of protecting these wires from falling telegraph and telephone wires by means of a split tube of ebonite or similar material sprung on to the upper half and reinforced by clip springs suitably insulated.

A. E. L.

511. *Electrolysis by Earth Returns.* **A. Larsen.** (Elektrotechn. Zeitschr. 23. pp. 841–842, Sept. 18, 1902.)—The present experiments are an appendix to others [see Abstract No. 619 (1902)] on the leakage currents from electric tramways to gas- and water-pipe systems. Pieces of iron tubing were placed in earth and currents passed from them through the earth to surrounding cylindrical iron mantles; the earth was moistened from time to time and in some instances impregnated with salt. The amount of corrosion was determined by scraping and reweighing the pieces of iron tubing from time to time. From the data it appears that the loss of weight of the tubes per ampere-hour was independent of (1) the current density, (2) the voltage, (3) the nature of the iron (whether wrought or cast), (4) the presence or absence of salt, (5) the character of the current (whether steady or intermittent). The e.m.f. of polarisation was proportional to the working e.m.f., and manifested itself as an apparent increase in the resistance of the earth. [See also Abstract No. 435 (1903)].

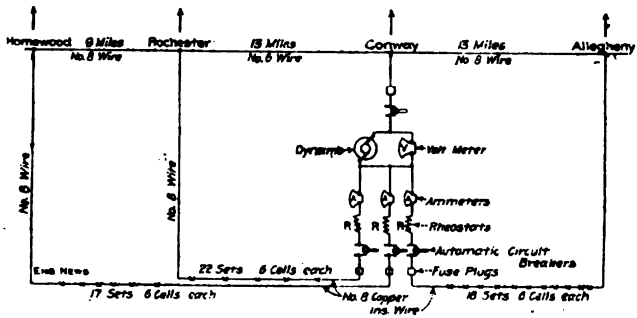
D. H. J.

512. *Third-Rail Traction and Sleet Storms.* (West. Electn. 31. p. 459, Dec. 27, 1902.)—On the Chicago electric railways ice and sleet are removed from the third rail by means of brushes of steel wires carried on the trucks.

Digitized by Google

If these are ineffective, a hand scraper is used in addition. The Hedley scraper, which consists of steel plates clamped together and pressed on the rail by a spring, is said to be very efficient. Oil applied to the rail prevents the formation of ice, but gathers dust, forming a gummy paste and spoiling the contact. A. H. A.

513. *Block Signals.* (Eng. News, 40. pp. 403–405, Nov. 13, 1902. Abstract of Report of the Annual Meeting of the Railway Signalling Club at Pittsburg, Pa., Nov. 11, 1902.)—Describes the system employed on the Pittsburg, Fort Wayne, and Chicago Railway. The blocks are from half-mile to three-quarter-mile long, except through interlockings, in which case they merely extend between the enlocking limits. The block signals are three-position electric motor semaphores. The three-position signal is the standard block signal for the Pennsylvania lines west of Pittsburg. Distant signals for interlocking are automatic signals and are located a full block away from the home signals. They stand normally at caution, that is, 45° from the horizontal, and are cleared through a circuit closer on the home signal, when the home signal comes to the clear position. The home signals for all interlockings are two-



arm, with the lower arm mechanically connected and the upper arm semi-automatic. The upper arm is worked by a circuit controller operated by the latch of a regular mechanical lever in the machine. This lever does no mechanical work except to operate the mechanical locking. The circuit is so arranged (by the use of a stick relay) that after the lever has been reversed and the signal cleared, a train passing on to the block section causes the track relay to open, which in turn causes the signal to go to danger. After a train has passed out of the block the signal will not clear again until the leverman puts his lever "home" and reverses it again. The home signal levers are also electrically locked in the reversed position, if either the home or distant signal fails to go to danger when it should. This prevents the leverman from changing the route until the trouble has been cleared up. The signals are operated by storage batteries placed in 5 × 7 steel wells; six cells of chloride accumulator, type D-5, are used, and their capacity is sufficient to operate four signals on a bridge simultaneously. Each well has two sets of storage cells, so that one set is charging while the other is discharging. The charging is done as follows: Each signal repairman goes over his section, about seven bridges, the first thing each day, and throws a rotary knife switch in each battery well. This switch transfers the charged battery to the operating system and the discharged battery to the charging line. While the batteries are being charged they are cut entirely free from the operating system. The

Digitized by Google

charging is done from a power station, located in the Conway roundhouse, by means of aerial charging line, into which the batteries are connected in series. The batteries are charged for eight hours a day. The voltage at the power station is 550 to 600, and over half of this is needed to overcome the drop due to line resistance.

The accompanying sketch of the charging circuit shows that the batteries are connected in three groups. The division is made so that each group can get from 1½ to 2½ amperes with all the batteries in circuit. Any well can be cut out of the line, so that in case of a break down one or two sets of battery can be charged at a high rate. The power station is equipped with engines and generators in duplicate, so that either generator can be used to charge one or all three charging groups. E. O. W.

514. *Railway Signal Circuits.* **J. C. Mock** and **W. E. Foster.** (Railroad Gazette, 84. pp. 870–871, Nov. 14, 1902. Report for Railway Signalling Club.)—Advocates the three position automatic block signal and the normally clear arrangement. It reduces the number of lamps and arms and requires no more complex mechanism. Blocks should be uniformly ¾ mile, rather less for up grades and rather more for down grades for uniform time intervals. Semaphores should be wholly electric. They are preferable to discs or banners. The normal clear position is favoured because the controlling circuits are simpler, the signals are more readily inspected and easier to maintain, and are less liable to derangement from lightning. These considerations outweigh the claims that the normal danger is the consistent position (with relation to interlocked signals), is more economical in batteries, is less liable to give false signals. Storage or primary batteries for signals must be adopted with consideration of first cost and maintenance charges. The former require a power circuit but are preferable. The wireless method of controlling distant signals is favoured. For lightning guards, choke coils and spark-gaps are recommended, but not fuses, owing to delay involved in replaceals and insufficient protection afforded by them. Miniature signals as switch indicators, instead of bells, are preferred as more reliable and requiring less batteries. E. O. W.

REFERENCES.

515. *Cost of Electric Power Transmission.* **A. D. Adams.** (Cassier, 22. pp. 652–657, Oct., 1902.)—This is an instructive article dealing with the estimation of the costs of power-transmission schemes, based on recent practice in California. G. W. DE T.

516. *Electrical Standards and Rules for Installations.* (Elektrotechn. Zeitschr. 23. pp. 762–764, Aug. 21, 1902.)—Rules are laid down for the construction and installation of switches, lamps, and other apparatus with a view to safety. The tests to be applied in each case are formulated, and stipulations are made regarding the materials to be used. Particulars are given of the form in which test-specimens of iron should be prepared for Reichsanstalt tests of magnetic qualities, and details of the method of testing them. R. A.

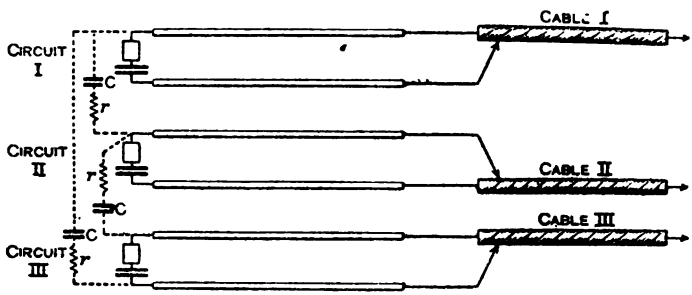
517. *High-Speed Electric Interurban Railways.* **G. H. Gibson.** (Eng. Mag. 23. pp. 858–886, Sept., 1902.)—The paper discusses the recent development of high-speed interurban electric railway work in the United States and in Europe, pointing out how far Europe is behind the United States in this respect. G. W. DE T.

Digitized by Google

TELEGRAPY AND TELEPHONY.

518. *Submarine Cable for the Mexican Government.* (Elect. World and Engineer, 40. pp. 958–960, Dec. 18, 1902.)—The United States have taken up the manufacture of submarine cable within the last few years. Last year the Safety Insulated Wire and Cable Company made and laid a cable for the Mexican Government between Vera Cruz, Frontera, and Campeche, 544 statute miles. The conductor is of 8 wires spiralled round a large central wire, insulated with pure and vulcanised rubber. This core, in 5-mile lengths, was subjected to 5,000 volts alternating for five minutes : then made up with jute, compound, and armour as usual. Finally tested with 1,000 volts direct current. No cable ship was available, and it was difficult to find one of suitable accommodation. Finally a steamer was secured which had no 'tween deck, and, to make room for the tanks, it was only necessary to remove some vertical stanchions. The tanks were wooden crib cylinders supported by ties and girdled by steel ropes. E. O. W.

519. *Disturbances on Underground Telegraph Cables.* **W. Schönau.** (Electrician, 50. p. 848, Dec. 19, 1902.)—A seven-core cable in a lead tube is used to connect Shanghai with Woosung, and three submarine cables at the latter place. The return circuits are earthed at Woosung. No brass tape is



used on the cores, and considerable induction and earth disturbances ensued. These were remedied by introducing condensers and resistances as shown at C and *r* in the diagram. The values were found experimentally, and in the case described are about 0·1 m.f. and 100,000 ohms. The author suggests such an "induction balance" for land-lines as well as cables, each circuit being protected against each of the others by this method. E. O. W.

520. *Central Telegraphic Commutator at Amsterdam.* (Journ. Télégraph. 26. pp. 241–244, Nov., 1902.)—This has been instituted on the principle of a telephone switchboard to admit of 100 circuits being connected over through relay translators for the purpose of exchanging their telegrams direct without manual repetition at the central. Calling indicators are employed as usual. While two offices are in communication, the plugs and jacks are so arranged as to cut out the indicators, and to cause a lamp in each circuit to glow, which shows that the circuit is occupied. When the lines are done with, a button is pressed in one of the offices, and actuates a signal in the

Digitized by Google

exchange. For the 100-line board there are 12 relay-translators and clearing signals. The board can be worked at busy hours in two sections of 50 lines each by two operators. E. O. W.

521. *The Transmission of Fire Alarms.* **E. B. Ellicott.** (West. Soc. Engin., Journ. 7. pp. 623–644; Discussion, pp. 644–650, Dec., 1902.)—The system of the Chicago Fire Department is described. In the street box there is a segment of a gear wheel, set in mesh with a small geared ratchet which is arranged to engage the reduction wheel when the segment has been pulled down far enough to give at least one complete revolution of the character wheel. It is impossible to actuate the mechanism without making a complete record of the box number at the office. The teeth on the character wheel are spaced to represent a certain number which identifies the location of the box. Generally the design provides for repeating this number four times. The pulling down of the segment of gear winds up a spring which furnishes the necessary power to restore the mechanism to its position of rest, during which operation the character wheel has been revolving several times. Assuming a box has been pulled, the first break of the character wheel allows the armature of a sensitive relay at the office to bring into circuit a bell, an annunciator, and a lamp. These signals are independent of each other, and the failure of one will not upset the performance of the others. When the bell sounds a switch can, if required, be operated so as to bring a printer into circuit to record the call. At a call box there are also lightning arresters, a key, and a signal bell or sounder, as it is necessary to provide means for intercommunication with the office for repair parties, or special code alarms. The mechanism is in a dust-proof box, and there is an outer protecting box for the whole. The switch at the office can bring the sounder, or bell and key, circuit into use when requisite. The apparatus in the fire alarm box is automatically shunted when at rest, and is only brought into circuit when the box is pulled. So much for the street box and signal line. An alarm having been received, it is sent to each and every engine-house, battalion chief's quarters, and police stations. The system described for this and subsidiary purposes explained is due mainly to J. P. Barrett, of Chicago. Two lines go to each group of engine-houses. On one line at the main office is an electrically-operated pole changer, which by the use of a key sends an alternating current to line which operates a polarised relay at each engine-house, and thus causes a local printer to record on tape what is signalled. The number of the street box from which an alarm has been received is thus communicated. The same line is also used with direct-current relays and keys by means of which Morse signals can be transmitted for instructions, and for reports of engine companies when they return from fires, as well as for the use of repairers. The receiving and sending of an alarm is briefly described as follows: Simultaneously with the pulling of the street box the annunciator on that line at the main office falls and an alarm bell rings calling attention of the operator, who switches the register into the local circuit of the relay and obtains two perfect records of the box number. At each bank of relays there is located a key controlling the pole changers in circuits running to all engine-houses. The operator reproduces the box number twice on each key, using first the key that controls all alarm lines in which there are only polarised relays. This prints two records of the box in each engine-house. Immediately following it is repeated on the key controlling the pole changers in the sub- or secondary alarm lines, and two more records of the box are printed in a like manner, and if the attendant at each engine-house is not

Digitized by Google

at his post to hold out of service the large gong, also actuated by the relay, it will sound, and awaken the men. It might seem that the operation of this system would be slow, but the average time is practically only 24½ seconds. At one time "non-interference" boxes were in use to provide that, if two boxes should be simultaneously pulled, one should not interfere with the other. These were found unnecessary. It is now arranged that the consecutive numbers of boxes likely to be pulled at the same fire are different or have distinct features so that the operator receives intelligible signals sufficient for the occasion. Three boxes pulled simultaneously have been thus located without difficulty. The use of motor generators instead of storage batteries for furnishing current is extending. Since 1898 nineteen circuits have been so supplied. But there are reserve batteries. The author also describes some automatic fire alarms, mercurial, fuse wire, metal strip, and others. The multiphase cable has a number of copper wires wound round a fusible wire but separated from it by thin braid soaked in easily melted compound. When the cable is heated the compound and fusible wire both melt, and a circuit with the copper strands is established. The system is practically a continuous thermostat. But the difficulty is to obtain fusible wire which will always be at a given temperature. One of the most ingenious systems was recently exhibited, and under ordinary tests operated satisfactorily. The system comprises a ¼-in. pipe run through a certain section of a building and terminating in an annunciator of special construction, which, instead of operating by the application of an electric current through a magnet, responded to an increase of air pressure in the pipe. This increase of air pressure was obtained by means of an explosive cartridge inserted in the pipe at frequent intervals. The head of the cartridge was exposed, and upon application of a certain temperature exploded and thereby increased the air pressure within the pipe, throwing the drop on the annunciator. The drop on the annunciator not only indicated the section of the building in which the excessive heat existed, but was also arranged to set into operation a transmitting device which terminated in a central station, where a register could be employed to record the alarm. In one instance this transmitting device was connected to a central telephone system, and the operator obtained the alarm by the flashing of the signal lamp. No changes were required in the telephone circuit, and it was used for business as well as a fire alarm line.

E. O. W.

522. *Automatic Substation System for Telephone Exchanges.* **J. Baumann.** (Elektrotechn. Zeitschr. 23. pp. 907–911, Oct. 9, 1902.)—In this system, used by the German Post Office, one of the features is the means for enabling any one of a series of substations to be called up by the exchange without calling the others. This is effected by means of a special form of bell in which the electromagnet has two windings, one arranged in the line circuit, and the other in a local circuit, including the armature of the bell, a fixed contact and a local battery. By this means, when the armature is attracted by a current in the line, the local circuit is completed, and the magnetism produced by the resulting current neutralises that produced by the line current in the winding first mentioned, so that the armature is no longer attracted, thus producing the vibration of the hammer. By this arrangement the bell can be arranged to work between two definite values of the line current only. By inserting two resistances in series with the calling-up battery, three substation bells can be actuated, and by reversing the current, three more. An interval of from 10 to 15 milliamperes is sufficient for the whole of the above.

Digitized by Google

It has been observed that the pressure of the battery at the exchange used for sending the graduated currents may sink 30 per cent. below its normal value without interfering with the signalling. These special bells are arranged in series in a separate circuit, the substations being connected in parallel on the line. When the receiver is taken off the hook at the called station, the bell at this station is cut out of the separate circuit, and at the same time, by means of automatic switches controlled by the current in the separate circuit, the other substations are disconnected from the line, and indicators are operated at these substations to show that the line is engaged. In order to call up the exchange from a substation, the receiver is first taken off its hook, and then the magneto actuated. A separate line is also provided for speaking between the substations on each main connection, each of these substations having a series of jacks whereby the desired connection can be made. In this case a switch is provided for disconnecting the main line or connection during the conversation between the substations. The connections are very fully described with reference to a diagram.

C. K. F.

523. *Variation of Tension of Telephone Wires.* **P. Vandeuren.** (Ecl. Électr. 38. pp. 14–26, Oct. 4, 1902.)—The author considers in detail the effect on tension, of variation in span, in temperature, and in overloads (snow, &c.), and applies his results to cases occurring in practice; it is necessary to take account of variation in the elastic elongation. He then goes on to consider the bending couple which the wires apply to the supporting posts, and to calculate what dimensions should be given to the posts. The mathematical results obtained should be useful in practice.

W. S.

REFERENCES.

524. *Testing Cement Conduits.* **M. Gary.** (Tech. Versuch. Berlin, Mitth. 20. pp. 56–62, 1902.)—The tests here summarised were undertaken on behalf of the German Post Office on various makes of conduit having ducts of 10 cm. diameter. Two types were tested, viz., the so-called Frankfurt system, in which the ducts are arranged side by side in one row, and the Swedish system, in which the ducts are arranged above or beside one another in any manner found convenient. Sections of the various conduits are given, as are also the breaking stresses in the different cases.

W. H. S.

525. *Common Battery Switchboard Specifications.* **C. L. Goodrum.** (American Telephone Journal, 6. pp. 277–279, Nov. 15, and pp. 291–292, Nov. 22, 1902.)

Digitized by Google

SCIENCE ABSTRACTS.

Section B.—ENGINEERING.

JULY 1903.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

526. *Valve for Compound Engine.* (Mech. Eng. 11. pp. 81–82, Jan. 17, 1903.)—The paper contains a description, with drawings, of a new form of slide-valve devised by C. E. Beardmore. A single valve placed between the two cylinders distributes the steam to both; the principal object of the arrangement is to reduce the clearance in the steam ports, and to this end the section of the face of the l.p. ports is V-shaped (partly embracing the cylinder) instead of flat. H. R. C.

527. *Superheated Steam.* **E. Foster.** (Eng. Record, 46. pp. 609–610, Dec. 27, 1902. Abstract of a paper read before the Engine Builders' Association of the United States.)—This is a *résumé* of the practical advantages of the use of superheated steam, the author favouring a moderate superheat of from 100° to 150° at the boiler, giving about 100° at the engine, rather than highly superheated steam, although temperatures of 750° have been successfully used. Comparing saturated and superheated steam on a heat unit basis, which ignores the cost of the superheat, the author assumes 12½ lbs. of water per i.h.p. for an engine of 1,000 h.p. running with 150 lbs. initial pressure and 26 in. vacuum, and states that there are authenticated records of a similar engine supplied with steam of 720° F. at the boiler consuming less than 9 lbs. of steam per i.h.p., or a gain of 39 per cent. in economy with an expenditure of only 16 per cent. more heat units in the boiler. As a rough approximation, superheating will also make a difference of 20 per cent. in the size of steam pipe required. The velocity of steam in the pipes should be from 4,000 to 6,000 ft. per minute, and if the pipes are well made and covered there should not be a greater drop of temperature per foot run than 1° in 6 or 7 feet of length. The effect of superheated steam on the indicator diagram should be kept in mind in designing engines. Steam being used as a perfect gas, the diagram approaches the theoretical, the tendency of pressure to rise during the stroke is absent, and the amount of work done in the low-pressure cylinder is brought down to the proper point. [See also Abstracts Nos. 2231 and 2242 (1901).] F. J. R.

Digitized by Google

528. *Combined Surface Condenser and Cooler:* (Eng. News, 48. pp. 546–547, Dec. 25, 1902.)—Illustrations are given of a surface condenser in which the cooling of the tubes is effected by the combined action of an air current and a water spray. The condenser consists of a cylinder of given diameter closely packed with 1 in. copper tubes 5 ft. long between the tube plates. The exhaust steam is in contact with the outsides of the tubes, the air and water spray being passed through inside. The spray pipe is fitted with a rose having holes 0·025 in. in diameter, and for the largest condensers the pipe has only 1½ in. diameter. An average pressure of 25 lbs. is sufficient to distribute the water over the tube plate, the distance between rose and plate being 30 to 48 in. Tests of a 86 in. condenser with 296 tubes and 887·5 sq. ft. area of cooling surface gave the following results :—

Duration	1 hour.
Condensed steam	1,545·3 lbs.
Condensing water lost	1,193·8 „
Spray water pumped (calculated)	6,282·0 „
Temperature, condensed steam	158° F.
„ city water	59° F.
„ spray water	112·88° F.
„ waste condensing water	125° F.
„ air	80° F.
„ fan exhaust	126° F.
Speed of fan—r.p.m.	810
Air exhausted by fan (calculated)	21,243 lbs.
Indicated h.p.	51·44
Steam per i.h.p.	30·04 lbs.
Heat in exhaust steam above 32° F.	1,754,379 B.Th.U.
„ in condensed steam above 32° F.	187,492 „
„ abstracted from steam	1,566,887 „
„ in city water above 32° F.	32,244 „
„ in exhausted condensing water	1,368,969 „
„ absorbed by condensing water	1,336,725 „
„ „ air	165,058 „
Radiation loss	65,104 „
Condensed steam per sq. ft. cooling surface per hour	3·98 lbs.
Condensing water lost per lb. of condensed steam	0·77 lb.

F. J. R.

529. *Sederholm Boiler.* (Eng. Record, 46. p. 584, Dec. 20, 1902.)—This is a modification of the return tubular boiler, the novelty being the addition of several transverse water-heating drums below the main boiler shell. These drums extend entirely across the furnace and combustion chamber, and are arranged to cause the gases to pass to the rear of the setting before coming in contact with the shell above. The gases pass forward over the tops of the drums, and below the shell, to the front, and then backward through the return tubes. Each drum is connected at each end and in the middle to the shell above by large pipes having flanges riveted to their ends and to the shell and drums. In three trials, the first with New Kentucky coal having a heat value of 12,870 B.Th.U. per lb. of dry coal, determined by calorimeter, and the second and third with New River coal of 14,932 B.Th.U. per lb. by Dulong's formula from ultimate analysis, the evaporation from and at 212° F. per sq. ft. of heating surface per hour was 3·87 lbs., 4·38 lbs., and 3·43 lbs. The combustion per sq. ft. of grate surface having been, of dry coal per hour, 24·9 lbs., 28·3 lbs., and 16·8 lbs. respectively. F. J. R.

Digitized by Google

INDUSTRIAL ELECTRO-CHEMISTRY AND GENERAL ELECTRICAL ENGINEERING.

530. *Storage Battery Curves.* **C. Hering.** (Electrochem. Ind., Philadelphia, 1. pp. 122–125, Dec., 1902.)—The article commences by pointing out that, just as with dynamo machinery, or, more especially, incandescent lamps, so also the cheapest and most suitable battery to be used under any given conditions is a compromise between practical and theoretical considerations; generally between first cost and depreciation in some form. It then proceeds to describe how curves may be prepared in which the required information will be indicated as a minimum or maximum point, and several typical cases are discussed in detail. Only general principles are considered throughout, and no actual absolute values of any kind are given. E. J. W.

531. *Electrically-driven Machine Shops.* **L. R. Pomeroy.** (Railroad Gazette, 34. pp. 958–960, Dec. 19, 1902. Abstract of a paper read before the Central Railway Club, Nov. 14, 1902.)—The losses in a steam-driven shop are variable; they depend on design, working conditions, &c. Kennedy has stated the loss by mechanical transmission as being 22 per cent. in a certain case he investigated; Richardson has put it at 43 per cent.; Crompton at 32 per cent.; Fessenden at 69 per cent., this being the mean of 108 shops; the Baldwin Locomotive Works found it to be 80 per cent. before they adopted electrical driving; a test on the Chicago, Milwaukee, and St. Paul Railway of a planing mill, using 500 h.p. when the machines were fully loaded, showed that 75 per cent. of this was used to drive the shafting. The loss through condensation in steam pipes with the best lagging amounts to an equivalent in steam of one-sixth of a ton of coal per annum per sq. ft. of pipe surface; with unlagged pipes it is said to be half a ton, the pipes being continuously under steam. Finally, the inefficiency of small and scattered engines is obvious. As an instance of the saving effected in particular cases, a diagram is given showing the cutting speed and time taken to face up a 72-in. cast-iron disc from a maximum diameter of 72 in. to a minimum diameter of 6 in. A mechanically driven lathe took 59 minutes to do the work with three different steps on the pulley, the time occupied in shifting the belt not being included; a lathe driven by a motor with field control did the work in 31 minutes, *i.e.*, 53 per cent. of the same time. This is due to the fact that with an electrically-driven tool the cut is done at the maximum speed that the work permits; the workman gradually increases the speed with the controller as the diameter of the work decreases, and thus maintains a constant cutting speed. This is not possible with a series of pulleys, and the moment at which to change from one pulley to the next depends largely on the judgment of the workman. As for the production of a variable speed, an increase of 25 per cent. above normal speed can be obtained by weakening the field, a motor capable of standing this without sparking costing about 5 per cent. more than the standard type. If a variation in speed of 2 to 1 is required, a specially-designed motor with small armature reaction is necessary. A reduction of speed can also be produced by inserting resistance in series with the armature. W. H. S.

Digitized by Google

532. *The Operation of Automatic Circuit-Breakers and the Effects of Short Circuits on Dynamos.* **B. Hopkinson.** (Inst. Civil Engin., Proc. 151. pp. 8–12, 1902.)—Circuit-breakers at present used are either of the magnetic blow-out or carbon-break types. The operation of a circuit-breaker is divisible into three stages. In the first the plunger is rising, and the time it occupies depends on the distance of travel and the current. In the second stage the spring is opening the switch, and the time here required depends on the spring strength and blade inertia. In the third stage the current is being cut off. There is no back e.m.f. in the first two stages, as the circuit is still closed. It is important to know the time occupied in the first two stages together, and also in the third. The strains on the dynamo and flywheel are dependent on the first stage, as is also the heat due to short circuit, and the second determines the insulation stress.

The author's experiments were carried out with switches of the magnetic blow-out and carbon-break types. A battery of 260 cells was connected in series with a circuit breaker, a shunt of 0·0016 ohm resistance, and a gap which could be closed by a swinging bridge piece attached to a pendulum. The bridge piece was carried lightly by the pendulum, and arranged to stick in the jaws of the gap while the pendulum moved slightly forward and made contact with a small adjustable spring connected to resistances, in parallel with the shunt mentioned above. A slide wire on the resistances was connected, through a ballistic galvanometer and low resistance battery, to the extension piece on the pendulum. Adjustments were made until there was no throw on the galvanometer, when the short circuit was made. The results are shown in Tables I. and II. The first column gives the intervals

TABLE I.

CARBON-CONTACT CIRCUIT-BREAKER.

(Range 225–525 amperes; set for 295 amperes.)

Second.	Amperes.	Amperes.
0 to 0·018	3,500–3,700	3,600
0·036	2,750–3,170	3,000
0·045	2,250–2,550	2,400
0·050	900–1,580	1,300
0·054	(?) –1,140	
	(Lower limit not found.)	
0·058	Current always less than 900 amperes.	
0·063	Current always zero.	

TABLE II.

MAGNETIC-BLOW-OUT CIRCUIT-BREAKER.

(Range 300–800 amperes; set for 300 amperes.)

Second.	Amperes.	Amperes.
0 to 0·036	3,400–3,550	3,500
0·045	2,950–3,250	3,150
	(Only once below 2,700.)	
0·048	Current always less than 1,140 amperes.	
0·050	Current always less than 900 amperes, sometimes zero.	
0·053	Always zero.	

between the time of making an observation and the moment of first contact between the bridge piece and the jaws of the contact blocks; the second column gives the minimum and maximum values of the current for a large number of observations, and the third column gives the most probable values of the current. With additional resistance in series, the carbon breaker remained at about 1,050 amperes for 0·045 second, then began to fall, at first gradually, and afterwards more quickly, ceasing to flow at 0·075 second. With the magnetic blow-out, the same current continued for 0·054 second, ceasing to flow between 0·068 and 0·07 seconds. The cut-off was slower than with the larger current because the magnetic field which blows out the arc is generated by, and is proportional to, the current through the circuit-breaker. Experiments relating to the time of opening and the setting of the breaker showed that the carbon breaker passed 196 ampere-seconds on a dead short circuit when set at 225 amperes, and 217 ampere-seconds when set at

Digitized by Google

525 amperes, a time difference, at the maximum current of 4,000 amperes, of 1-200th second. The magnetic blow-out type, set at 800 amperes, passed 256 ampere-seconds, compared with 240 ampere-seconds at 800 amperes, a time difference of 1-250th second. The effect of a short circuit on the electrical plant is considered, and tests were carried out with a 1,500-kw. unit at 600 volts. At no load it was concluded that the current would rise to 2,500 amperes in less than 1-100th second, a second similar current being added in less time than the first. On short circuit at full load the current would reach 7,000 amperes (with carbon breaker) before the current began to open, while, with the magnetic blow-out type, it might reach 12,000 amperes but for resistance, which would lengthen the later stages of the rise. Neither type opened the circuit soon enough to prevent current in the protected machine rising many times above its normal value. With a non-inductive circuit the carbon type opened in about 0·015 second, and the blow-out in 0·005 second. If a break were similarly effected with the 1,500-kw. unit, the average inductive e.m.f. would be 880 volts with the former, and 1,000 with the latter types of switch.

W. E. W.

533. *Siemens Electric Steering Gear.* (Electrician, 50. pp. 803–805, Dec. 12, 1902.)—In this gear the ends of the tiller are connected by links to two nuts which slide in guides so as to prevent them from turning, and engage respectively with right- and left-handed screw-threads formed on a horizontal shaft rotating in bearings on the deck. This shaft can be coupled by interconnected clutches, either to a sleeve bearing the steering-wheel, or, through gearing, to a 4-pole 100-volt motor, so as to permit of either electric or hand power being employed. The motor is normally prevented from rotating by means of a spring-actuated brake, which is automatically released as the motor starts by an electromagnet in series with the motor. The reversing switch controlling the supply of current to the motor comprises two discs, one geared to the screw-threaded shaft and the other geared to the sleeve bearing the steering-wheel. One of these discs bears two pivoted switch-arms, each co-acting with a series of fixed contacts, and the other projections, each switch-arm being arranged to clear the projections when the disc bearing these projections moves in one direction, and to engage them when the motion is in the other direction, so that one switch only is operative in each direction of rotation. By this means the motor is caused to turn so that the motor-disc follows the steering-wheel disc. The movement of the steering-wheel is limited by a Geneva stop to 40° in each direction. The paper is fully illustrated by working drawings and a photograph.

C. K. F.

534. *The Morawetz System of Electric Clocks.* **Kareis.** (Zeitschr. Elektrotechn., Wien, 20. pp. 553–555, Nov. 9, 1902.)—In this system the master clock consists of a pendulum which bears a projecting pin, whereby it releases a spring detent once each complete oscillation (*i.e.*, once each second) and thus allows a heavy arm to fall; this arm, in falling, moves a lever whereby an impulse is given to the pendulum through the pin above mentioned. The heavy arm is raised again by means of an electromagnet, the armature of which forms an extension of the heavy arm, the circuit of this electromagnet being completed when the arm falls, by a gravity mercury switch enclosed in a glass tube mounted on the arm. When the arm is raised by the electromagnet, the circuit of the electromagnet is broken and the spring detent retains the arm in its raised position until the detent is

Digitized by Google

tripped again by the pin on the pendulum, after which the cycle of operations is repeated.

The above seconds-mechanism actuates a minutes-mechanism as follows: In the circuit of the electromagnet above mentioned is arranged a second electromagnet, which, by means of pawls and a ratchet-wheel, causes an arbor to rotate once a minute. To this arbor is fixed a projecting pin which, once each minute, trips a detent holding up a second arm that bears a gravity mercury switch and is raised by an electromagnet controlled by this switch. In the circuit of this electromagnet are arranged the secondary clocks, which consist of electromagnets actuating the hands through ratchet-mechanism. Diagrams of the mechanism are given in the paper. C. K. F.

535. *Methods of Testing Energy Meters (Aron System).* **M. Aliamet.** (Électricien, 28. pp. 841–843, Nov. 29; 861–864, Dec. 6; and pp. 874–876, Dec. 13, 1902.)—In the latest form of Aron meter each pendulum is provided with a coil arranged so as to produce an acceleration of one system and a retardation of the other. The current in these coils is automatically reversed every ten minutes in order to eliminate the asynchronous effects when no current is in the coils. The power (P) to be measured is given by the relation $N_1 - N_2 = n \cdot P/C$, where N_1, N_2 are the rates of oscillation of the accelerated and retarded pendulums, n is the rate of oscillation of each pendulum without current in the coils, and C is a constant depending on the moment of inertia of the pendulum and on the resistance of the coil. The author gives two methods of testing the form of meter. (1) The 20 minutes test in which a constant power is supplied and the instrument calibrated against a standard wattmeter. In order to eliminate any errors of the figured dial or eccentricity of the needles, one complete turn of the needle on the unfigured dial is taken, and this represents 300, 3,000, 30,000, &c., watts (according to the size of the instrument) for the above period. The objections to this method are the length of time required and the large expenditure of energy. (2) A shorter test is by Orlish's method of coincidences, which consists in observing the rate of change of coincidence in the oscillations of the pendulums (*a*) before the current is reversed without coils, and (*b*) after the reversal has taken place. During the same periods the rates of oscillation are also observed, and from the wattmeter readings the calibration of the meter is quickly effected. It is unnecessary to open the instrument during the test, as the moment of reversing is made evident to the ear. [See also Abstract No. 525 (1901).] E. S. A. R.

REFERENCES.

536. *Electrical Submarine Mines.* **J. S. Sewell.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1253–1258; Discussion, pp. 1424–1482, Oct., 1902.)—The paper deals with the general principles of handling electric submarine mines. G. W. DE T.

537. *Heinicke's Storage Cell.* **J. Zacharias.** (Centralblatt Accumulatoren, 3. pp. 262-263, Oct. 15, 1902.)—A description of the construction of the electrodes and a discussion of their merits. E. J. W

Digitized by Google

GENERATORS, MOTORS, AND TRANSFORMERS.

538. *Design of Dynamos.* **E. Korrodi.** (Elektrotechn. Zeitschr. 23. pp. 1042–1043, Nov. 27, 1902.)—The value of the self-inductance e.m.f. is one of the most important factors in the design of a dynamo. Experiments have been carried out on this point by Messrs. Brioschi, Finzi & Co. The armature having been removed from the machine, one of the coils was disconnected from the commutator, its resistance determined by means of a volt- and ammeter, and then its impedance by sending an alternating current of frequency 50 through it. The following table gives the results of some of these experiments :—

Length of armature core in cms.	L =	20	15	23·5	16
Width of tooth (a); width (b) and depth (h) of slot in mms.	a, b, h =	8 ; 6·7 ; 16	8·7 ; 6 ; 32	8·5 ; 6·2 ; 32	9 ; 9 ; 20
Number of coils in series	s =	3	3	3	2
Number of turns in each coil	t =	3	4	3	10
Number of slots per coil		1	1	1	1
Determination of resistance	Volts	1·5	1	1	1
	Amperes	54	28·5	45	9·15
Determination of impedance	Volts	1	1	1	1
	Amperes	48·5	21	29	7·9
Power-factor, cos ϕ		0·9	0·74	0·645	0·865
,, sin ϕ		0·44	0·677	0·77	0·5
Reactance		0·0135	0·0322	0·0265	0·0635
Magnetic conductance	λ =	3·95	7·1	6·8	3

In the above, $\lambda = \dfrac{\text{Reactance} \cdot 10^8}{I^2 \cdot 2s \cdot \text{L} \cdot 2\pi \cdot \text{frequency}}$. A. H.

539. *Dynamo with Internal Field Magnet.* (Mech. Eng. 11. p. 46, Jan. 10, 1903.)—This is a description of a machine designed by Mavor and Coulson, with a four-pole internal field magnet on a fixed hollow shaft, the armature being mounted on sleeves which rotate on the fixed shaft. The outside of the armature may be used as the pulley, or it may be made into a motor fan by attaching the fan blades to the outside of the armature. R. B. R.

540. *The Thompson-Ryan Dynamo.* (Elect. Engin. 31. pp. 153–154, Jan. 30, 1903.)—This machine has a stationary bushing ring between the pole pieces and the armature. This ring has four slots in it for each pole, in which the balancing coils are wound. The object of these coils is to neutralise the distorting effects due to armature reaction, to provide a magnetic field for commutation, and for compounding. R. B. R.

541. *Armature Reaction and Hunting of Polyphase Generators.* **R. Goldschmidt.** (Elektrotechn. Zeitschr. 23. pp. 980–982, Nov. 6, 1902.)—The author gives an explanation of armature reaction and hunting which is mainly based on the consideration of the varying magnetic reluctance due to the polar projections of the field-magnet, and which involves the splitting up of

Digitized by Google

the armature current into two components, in phase and in quadrature respectively with the e.m.f. Each of these components produces a definite magnetic flux, and these fluxes give rise to e.m.f.'s in quadrature and in phase respectively with the main e.m.f. Assuming the two components of armature current to be equal, the author shows that—

$$\frac{E_q}{E_p} = \frac{\frac{b}{T} - \frac{1}{\pi} \cdot \sin\left(\frac{b}{T} \cdot \pi\right)}{\frac{b}{T} + \frac{1}{\pi} \cdot \sin\left(\frac{b}{T} \cdot \pi\right)},$$

where E_q stands for the induced e.m.f. in quadrature with the main e.m.f. and due to the component of current in phase with the main e.m.f., and E_p for the e.m.f. in phase with, but opposed to, the main e.m.f., and due to the component of current in quadrature with it; b = width of pole; T = pole-pitch. A table is given of the ratios E_q/E_p for different values of b/T. The author shows how to apply these results to the predetermination of the load characteristic for a given phase displacement of the armature current relatively to the e.m.f. He next considers the hunting of paralleled alternators, and shows that the period of the oscillation decreases with decrease of the pole-width. A. H.

542. *The Impedance of Alternator Armatures.* **F. Townsend, H. P. Freund** and **W. I. Reich.** (Elect. World and Engineer, 41. pp. 13–15, Jan. 8, 1903.)—Experiments on various types of machines are described to determine the relation of the synchronous impedance to the impedance found by passing alternating currents of known frequency through the armature, the rotor being kept at rest. The inductance (L) was found by passing a current through one phase, noting the volts (E), amperes (I), watts (W), and frequency $\left(\frac{\omega}{2\pi}\right)$, and using the formula—

$$L = \sqrt{E^2 I^2 - W^2}/I^2\omega.$$

The values found for L, varied by as much as 100 per cent., depending on the position of the rotor, but the variations due to changing the frequency were small, L being smaller at the higher frequency. Taking the mean value of L, the characteristic curve of a 5,000 kw. generator on a load whose power-factor was 0·4 was calculated by this method. It was also calculated in the ordinary way from the short-circuit and open-circuit characteristics. The p.d. drop found by the latter method is more than double that found by the former. This is due to the fact that armature reaction is neglected in the first method. A. R.

543. *Three-wire System for Variable Speed Motor Work.* **N. W. Storer.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1553–1559; Discussion, pp. 1592–1604, Dec., 1902.)—The author describes a generator for a three-wire system designed to give the e.m.f. between the outer wires, with four collector rings connected to the armature winding as in a two-phase rotary converter. The leads from these rings are connected to auto-transformer or balancing coils, the middle points of which are connected to the neutral wire. He discusses the working of motors on the three-wire system. R. B. R.

544. *Continuous-Current Motors for Machine Tools.* **F. O. Blackwell.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1585–1591, Dec., 1902.)—The

Digitized by Google

author discusses the characteristics of different classes of machine tools, the requirements of motors for operating them, and the conditions limiting the range of speed variation. With step cone pulleys the minimum change of speed is usually from 25 to 50 per cent.; but with a variable speed motor, with a range sufficient to fill in between the mechanical steps, the tool may be driven always at the highest possible speed and maximum production. A lathe with speed adjusted by step cone pulleys only, took 59 minutes to face a 72 inch disc, and the cutting speed varied from 65 to 15 feet per minute; when driven by a motor the work was done in 81 minutes with a nearly uniform cutting speed of 85 feet per minute. R. B. R.

545. *A Variable Reluctance Method of Motor Speed Control.* **G. F. Packard.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1517–1527; Discussion pp. 1528–1529, Nov., 1902.)—The special pole-piece patented by F. A. Johnson is made hollow, and in the centre is a plunger of soft iron radially adjustable by a screw. When this plunger is in its innermost position its end forms part of the polar surface, when it is drawn back the air space is increased at the centre of the polar surface. With this motor the speed can be varied from 660 to 1,475; it can develop its full rated h.p. at any speed within that range, hence it follows that the torque must vary inversely as the speed. The efficiency at full load is 79 per cent. at maximum speed and 83·5 per cent. at minimum speed. R. B. R.

546. *Variable Speed Induction Motors.* (Ind. Élect. 11. pp. 557–560, Dec. 25, 1902.)—The ordinary method of varying the speed of induction motors is to insert resistance in the circuit of the rotor windings by means of slip rings. This lowers the efficiency of the motor. Attempts have been made to restore to the primary network the power otherwise wasted in heating the resistances. The *Société alsacienne de constructions mecaniques* has devised several novel methods to accomplish this. In one type, three-phase currents taken from the mains and transformed down, are fed into the rotor, which is wound like the armature of a continuous-current machine, by means of three brushes on the commutator, whose angular distance apart is 120°. The transformer ratio can be varied by a movable contact arrangement, and the variation of the pressure at the rotor brushes alters the speed. The principle is said to be somewhat similar to that involved in connecting the secondaries of two transformers in opposition, so that the power taken is only that required for the necessary losses. It is not stated whether there is much sparking at the commutator or not. Diagrams of actual machines are given, and the connections of a three-phase booster are shown which would obviate the necessity of having a three-phase transformer with terminals for various pressures. The Company is still making experiments to improve this type of machine. A. R.

547. *Four-speed Three-phase Motor and Shunt Motor for* 850–1600 *Revs.* **H. Behn-Eschenburg.** (Zeitschr. Elektrotechn., Wien, 20. pp. 624–628, Dec. 14, 1902.)—The paper gives a detailed description of the three-phase motors of the Oerlikon Company [see Abstract No. 862 (1903)]. The D.C. shunt motor has a normal speed of 1,000 r.p.m., but a variation in speed of 850–1,600 r.p.m. can be obtained with the machine running in either direction, with full current and constant position of brushes. Sparking at the brushes is kept down by means of a compensator field winding

Digitized by Google

embedded in slots in the pole shoes, exactly like an induction motor winding. The poles of this winding are staggered in relation to the shunt field-windings. R. C. R.

548. *Induction Motor Speed Regulation.* **M. Osnos.** (Elektrotechn. Zeitschr. 28. pp. 1075–1080, Dec. 11, 1902.)—The usual method of inserting resistances in the rotor reduces the torque by electrically wasting some of the rotor energy, and for economical regulation this wasted energy must be saved. Instead of a resistance, a counter e.m.f. may be introduced in the rotor-circuit, and this is most easily attained by the employment of a commutator. Besides speed regulation, a means of keeping $\cos \phi = 1$ is highly desirable, and one of the chief difficulties is the attainment of these two objects at one and the same time. The author gives a graphical theory of speed regulation, and arrives at the conclusion that the principle of the series machine leads to a solution of the problem. The speed regulation is carried out by altering the ratio of the transformers, while $\cos \phi$ can be maintained constant by altering the position of the brushes. The author claims that his machine is an advance on those of Heyland and Görges. [See also Abstract No. 498 (1903).] R. C. R.

549. *Measuring the Slip of Induction Motors.* **A. Meynier.** (Ind. Élect. 11. pp. 560–562, Dec. 25, 1902.)—The methods of Seibt [see Abstract No. 1194 (1901)] and Schüler are not suited for measuring the slip at high speeds, as they use a Joubert contact maker. The stroboscopic method of Samojloff [see Abstract No. 2172 (1901)] also fails when the slip is great (10 per cent.) or the frequency high. The operator also has to work in semi-darkness. The author's method enables the measurement to be made in the light, and gives directly the difference in the speeds of two shafts placed end to end, whether rotating in the same or in opposite directions. Hence the difference between the angular velocities of the shafts of an induction motor and of a synchronous motor can be found; and thus the slip calculated. In his simplest method he places on one shaft a circular cardboard disc, one semi-circle of which is white and the other black. On the other shaft he mounts a black semi-circle of cardboard. Looking across this latter at the circle, it will be seen that the white semi-circle is completely eclipsed once every time that one shaft gains a turn on the other. By counting the number of times that it is eclipsed in a given time we can find the slip. When the shafts rotate in opposite directions, a clearly defined black cross is seen, which is stationary when their speeds are the same, and when they are different, its velocity can be used to measure this difference. A. R.

550. *Six-phase Transformation.* **A. S. M'Allister.** (Amer. Electn. 14. pp. 566–567, Dec., 1902.)—Rotary converters operated six-phase will give from 35 to 45 per cent. greater output than when operated three-phase. Hence economy dictates three-phase transmission with transformation to six-phase at the converters. Various ways of effecting the transformation are described and illustrated by diagrams; some of these are of academic interest only; the more practical methods are described in detail. The simplest is to use three transformers, the primaries being either star or delta connected, and the secondaries star connected. A delta connection on the low-tension side as well as on the high-tension side has, however, the advantage that the break down of one transformer does not render the plant useless, as the two remaining transformers take the load of the missing one. B. P. S.

Digitized by Google

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

551. *Pole Lines for Power Transmission.* **A. D. Adams.** (Elect. Rev. N.Y., 42. pp. 46–47, Jan. 10, and pp. 83–84, Jan. 17, 1903.)—This is an article giving much practical information on the construction of pole lines. The table herewith compiled from the article gives details of several existing lines. Long transmission lines should follow the most direct route, the number of poles, cross-arms, and insulators increasing *directly* with the length, and the weight of conductors varying as the *square* of the length. The tendency is to carry transmission lines over private rights of way, especially where the power is great and voltage high. Deeds for conveying the easements for right of way provide that all trees or branches within one rod on either side of the line may be cut away. The right of way ranges from fifty to several hundred feet wide, it being necessary in forests to cut down all trees tall enough to fall on to the wires. In some cases two independent pole lines are erected with one or more circuits on each. Such double lines are usually run together, but on the Welland Canal system, the two lines of poles are respectively 85 miles and 87 miles long, and are located several miles apart. Having two lines prevents an arc started on one circuit communicating with the other, and there is greater ease and safety in repairs. It is also desirable to limit the inductance of the lines and the concentration of current on the outer layers of each conductor :—

	Distance, Miles.	Voltage.	How Located.	Number of Pole Lines.	Distance apart of Pole Lines in feet.	Size of Wire in Circular Mils.	Material of Wire.	Frequency.	Distance apart of Poles in feet.	Material of Pole.	Length of Pole in feet.	Material and Number of Cross-arms per Pole.
Rochester and Pelham *vid* Portsmouth	80·3	13,200	Mainly private rights of way	One			Copper		100	Chestnut	35	
Niagara and Buffalo	25	22,000	Mainly private rights of way 30 ft. wide	Two	30	12/350,000 6/300,000	Copper Aluminium		75 112			Yellow pine Two
Canon Ferry and Butte	65	50,000	Mainly located on private way	Two	40	3/106,500	Copper	60	110	Cedar	35 to 90	One
Colgate and Oakland	142	40,000	Mostly private way	Two		3/133,225 3,211,600	Copper Aluminium	60	132		25 to 60	
Electra and Mission San Jose, California	99	60,000				3 471,034	Aluminium	60		Square sawed redwood		Oregon Pine

Digitized by Google

Aluminium wire is only half the weight of copper of equal conductivity, so the span between poles may be greater, and has been as much as 150 ft. A body of water 3,200 ft. wide had to be crossed on the Colgate and Oakland Line, and the lowest part of the wire had to be 200 ft. above water level to allow vessels with the tallest masts to pass under. Two steel towers were built 4,427 ft. apart, one being 65 ft. high and the other 225 ft. Between these, four cables are suspended (each containing nineteen strands of galvanised steel wire), measuring $\frac{7}{8}$ in. in diameter. The breaking strain of each cable is 98,000 lbs., and it has the electrical conductivity of a No. 2 copper wire. The cables are supported on the towers by steel rollers, and the pull on each cable, amounting to 12 tons, is taken by an anchor, the cable being secured by a series of strain insulators. Wooden poles are used exclusively for transmission lines (iron is not suitable). Chestnut, spruce, pine, cedar, and sawed redwood are all employed. In favourable soils cedar lasts twenty years, chestnut twelve, and spruce and pine five years. A 80-ft. pole should have a top not less than 7 in. in diameter and the butt 12 in., such a pole carrying, say, three No. 2 wires. For a round pole 60 ft. long, the butt diameter should be 18 in. at least. The sawed redwood poles used on the Electra and Mission, San Jose, California, are of the following dimensions:—

Height.	Top.	Butt.	Depth in Ground.
Feet.	Inches.	Inches.	Feet.
35	7 × 7	12 × 12	5½
40	8 × 8	13½ × 13½	6
45	9 × 9	15 × 15	6½
50	10 × 10	16 × 16	7
60	11 × 11	17 × 17	8

In soft ground the hole is made 2 ft. larger than the butt of the pole, and then a foot of good cement concrete—one part cement, three sand, and five broken stone—filled in. The butts of poles are treated with hot tar, pitch, asphalt, or carbolineum. In Salt Lake City, salt is used. The pole tops should be pointed or wedge shaped to shed water, and painted or tarred. Some pole lines are painted throughout. Formerly it was common to carry two or more circuits on a single line of poles, but now the more general practice is to give each pole line only one circuit and each pole one cross-arm, except for the telephone cross-arm below the power wires. Gains or notches are cut in the poles to receive the cross-arms, which are held by one $\frac{3}{4}$ or $\frac{7}{8}$ in. bolt. Alternate poles in a line have the cross-arms bolted on opposite sides, and at corners double arms are employed. Yellow pine is a favourite wood for cross-arms, the section being not less than 5½ in. by 4½ in. They should be surfaced all over and crowned ¼ in. on top to shed water. After being kiln-dried, they are boiled in asphaltum or linseed oil. If longer than 5 ft. they should be secured by braces. Flat iron bar 1½ in. by ¼ in. is sometimes employed, but wood is better because of the insulation. Maple wood braces are used on the Canon Ferry and Butte line (50,000 volts), each brace being 3 ft. long and 3 in. wide, the braces being held by wooden pegs. Wood is the only material suitable for pins on which to mount the insulators, because iron tends to grind the glass or porcelain, besides reducing the insulation. Oak, locust wood, or eucalyptus wood is employed, the pins being boiled for several hours in linseed oil after being dried. On the Canon Ferry and Butte Line the pins are of seasoned oak boiled in

Digitized by Google

paraffin, and measure 17½ in. long by 2½ in. diameter in the middle. These support the insulators high enough to give a distance of 9 in. between the lower outside edges of the insulator and the top of the cross-arm. E. K. S.

552. *The Protection Value of "Earthing."* **K. Wilkens.** (Elektrotechn. Zeitschr. 23. pp. 1129–1130, Dec. 25, 1902.)—The author discusses the results obtained from Uppenborn's experiments, in which one pole of a dynamo was connected to an earth plate, while the other pole was connected through an overhead wire to a mast sunk in dry soil. The mast was also connected to a second earth plate. Two earth currents were found to exist, viz.: (1) From the base of the pole to the first earth plate; and (2) between the two earth plates themselves. The best protection is produced by diminishing the resistance of the "earthing" surfaces, e.g., by increasing the cross section or, if possible, making contact with underground streams of water. The bottom of the mast may also be surrounded by a metal cage made of wire sufficiently thick to take the maximum current. With a number of masts the metal cages may be connected in parallel either above or below the ground. [See also Abstract No. 1459 (1901).] E. S. A. R.

553. *The Use of Negative Boosters.* (Tram. Rly. World, 13. pp. 54–56, Jan., 1903.)—The article shows how to arrange and make the necessary calculations for negative boosters. For such a booster to be as efficient as possible the load taken by it should never exceed that necessary to fulfil the B.O.T. regulation limiting maximum potential difference to 7 volts. After discussing, by the aid of diagrams, the various ways which may be employed for controlling the output of a booster, an actual case is assumed of a single-track tramway four miles in length supplied with current from a power-house at one end of the line. There are eight car points, each absorbing from 20 to 25 amperes. From an easily understood formula it is calculated that the negative feeder should be 2,000 yds. long and 0·13 sq. in. in area, and the booster give 130 amperes at 49 volts. E. K. S.

554. *Power-Factor in Three-Phase Circuits.* **A. S. McAllister.** (Elect. World and Engineer, 40. pp. 947–949, Dec. 13, 1902.)—The author deals with power-measurement in three-phase circuits, and points out that there exists a certain amount of ambiguity in connection with the term "power-factor" as applied to such circuits, the meaning of the term depending on what is taken to be the apparent power in the circuit. He gives a semi-graphical proof of the two-wattmeter method of power-measurement. A. H.

555. *Power-Factor in Three-Phase Circuits.* **L. L. Perry.** (Elect. World and Engineer, 41. pp. 69–71, Jan. 10, 1903.)—Referring to McAllister's article [see preceding Abstract], the author points out that even in unbalanced three-phase circuits the terms "power-factor" and "angle of lag" have perfectly definite meanings. The currents in the lines being represented by a Y, and the voltages across the lines by a Δ, the Δ may be fitted over the Y so that the vertices of the Δ fall on the legs of the Y. The relative positions of the Δ and Y will then be correct if the load is a non-inductive one. If it is inductive, the Δ may be rotated about the centre of the Y until the total power corresponds to the true power. The cosine of the angle through which the Δ has been rotated then gives the power-factor. A. H.

Digitized by Google

556. *Connections of Regulating Batteries.* **H. de Waal.** (Assoc. Ing. El. Liège, Bull. 2. pp. 334–345, Nov., 1902.)—In this paper the author discusses different ways of coupling batteries used for regulating purposes, especially in tramway work, with special reference to the method in which a booster is used in series with the cells. If the generators, with which the battery runs in parallel, are overcompounded, a booster is necessary, otherwise the cells would act in the inverse sense to that desired; if the generators have a falling characteristic, no booster is required. The booster used in conjunction with overcompounded machines should have both shunt and series field winding, connected in opposition; the reason for this is explained, and, by a typical example, the working of the arrangement is numerically illustrated. As an example of actual practice, the Mexican tramways system is briefly described. The paper is illustrated by diagrams. [See also Abstract No. 2286 (1901).] B. P. S.

557. *Methods of Charging for Electric Energy.* **P. Lauriol.** (Écl. Électr. 33. pp. 325–337, Dec. 6, 1902.)—The author discusses this question in its general aspects, and recommends a system under which the charge for energy would vary according to the time of day at which the energy is consumed, the charge to be highest at that time of the day at which the station output is at its maximum. He mentions several ways in which this can be carried out in practice. Either two meters must be employed, or a method must be adopted by which the constant of the meter can be varied. This can be done by a clock on the consumer's premises, or from the central station, as on the Routin system. W. H. S.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

558. *Power House Equipment; Galveston City Railway Co.* (Street Rly. Rev. 12. pp. 869–874, Dec., 1902.)—The foundations and buildings are described. The maximum weight per sq. ft. is 2,400 lbs. The foundations are pile driven, the piling being done by means of a water jet. The *boilers* are of the Babcock-Wilcox vertical header type, fitted with Roney stokers. The furnaces are fitted for oil burning as well as for coal. Oil is at present used, and tests on this installation have proved that oil and coal may be used simultaneously or separately without any change in the furnace construction and without any perceptible difference in efficiency. Beaumont oil is used as fuel, a storage tank and duplicate pumps being provided to store and handle the oil, which is passed through a heating chamber and raised to a temperature of 120 to 130°, and thence through a special Worthington meter, before it enters the furnace. The feed-water pumps are in duplicate, and are connected with double crosses, both in the suction and discharge lines. This permits them to be used simultaneously, and to receive their supply from separate sources and feed separate boilers. The feed water passes through a Worthington meter, then through a primary heater which raises the temperature to 130°, through an auxiliary heater in which the temperature is raised to 200°, and finally through an economiser from which the water issues at 285°. *Generators.*—The station is designed to supply current to between 50 and 60 single truck cars, and for the public lighting of Galveston. The tramway plant consists of two 325 kw. 550 volt sets, each consisting of a 16 in. × 30 in. × 42 in. cross-compound (Filer and Stowell) Corliss engine, speed 100 r.p.m., direct connected to a G.E. railway generator. The guaranteed steam consumption is 14½

Digitized by Google

lb. per i.h.p. hour, with a steam pressure of 150 lb. per sq. in. and a vacuum of 22 in. All valves are double ported and adjustable, and the steam and exhaust valves are operated by separate eccentrics. The main bearings have wedge adjustment at the bottom and the sides, so that the brasses can be removed without raising the shaft. The lighting equipment consists of one 12 in. and 22 in. × 14 in. tandem compound Harrisburg engine, running at 275 r.p.m., direct-connected to a 125-kw. G.E. revolving field, 2,300 volt, two-phase generator; and a 13 in. and 26 in. × 28 in. Green-Wheelock cross-compound engine running at 150 r.p.m., direct-connected to a 200-kw. revolving field generator, of the same voltage. These two can be operated in parallel when necessary. The smaller set is for the day lighting and power load, and the second for the night load. The switchboard panels are of blue Vermont marble. Illustrations of the engine-room are given, together with plans and elevations of the piping arrangements, also full data of tests with coal and oil fuel. The evaporation per lb. of coal from and at 212° F. was 9·68 lb., and the cost of fuel per h.p. hour 1·01 cents. With oil, the evaporation figures vary from 11·91 to 14·9, and the cost per h.p. (A.S.M.E. rating) from 0·56 to 0·32 cents. The calorific value of the coal was 12,866 B.Th.U., and of the oil, 19,000 B.Th.U. per lb. Tests on the engines gave for the 325-kw. set 14·36 lb. steam per i.h.p. hour, for the 125-kw. set 19·82, and for the 200-kw. set 15·84. The corresponding figures per kw. hour at the switchboard are 22·36, 30·7, and 26. The amount of fuel oil per i.h.p. per hour was 1·59, 1·98, and 1·82, and the cost of steam per kw. hour (engine only) was 0·211, 0·302, and 0·250 cents respectively. F. B.

559. *Electrical Supply from Water Power at Portland, Me.* **A. D. Adams.** (Elect. World and Engineer, 41. pp. 65–68, Jan. 10, 1903.)—The water power utilised by the Portland Lighting and Power Company is situated on the Presumpscot River, and is known as "The Great Fall" in North Gorham, about thirteen miles from the substation in Portland. The Presumpscot River is the only outlet of the Sebago Lake, which discharges, on an average, about 800 cubic feet of water per second. The dam at Great Fall is 450 ft. long, 22 ft. high, and 24 ft. wide at the bottom, and is built on a solid ledge. This ledge provides 15 ft. of the total 37 ft. used. Behind the dam is a pond about one mile long, 1,000 ft. wide, and 15 ft. deep, serving to store or release water as required during the daily fluctuations of load. Four steel penstocks pass to the generating station, entering the forebay wall 10 ft. below the surface of the water in the pond, avoiding in this way all anchor ice troubles. Each penstock delivers water to a pair of Victor turbines, and each turbine case contains a pair of wheels 33 in. in diameter, of the central discharge type, operating at 225 r.p.m. under a head of about 37 ft. Each pair of wheels is rated at 880 h.p., and is directly connected to a 500 kw. generator. The four 500 kw. generators are of the revolving magnet type, three-phase, 60 ∿, and operate at 10,000 volts. There are four transmission lines of three wires each, carrying the current at 10,000 volts over a distance of about 13 miles, where it is transformed to 2,500 volts. The motor, street lighting, and commercial lighting circuits, are each fed from a separate generator. The high tension line consists of No. 2 bare wire of solid soft-drawn copper. The standard poles used are of chestnut 30 ft. long and with a 7-in. top; all sharp angles are made with two poles set 6 or 8 ft. apart. One of the transformer houses contains three oil insulated Wagner transformers rated at 150 kw. At the other transformer house there are six 200 kw. transformers, three of them air cooled and three oil cooled. The fourth generator and transformer are not

Digitized by Google

yet in position. The substation contains one 250 kw. three-phase, 60 ∿ generator, connected by a rope to a 250 h.p. steam engine, used only occasionally. The substation contains also a 200 h.p., 2,500 volts, three-phase, 60 ∿ induction motor, connected, at each end of its shaft, to a Brush arc dynamo of 8,000 volts, and 6·6 amperes capacity, to feed the street enclosed arc lamps. One constant-current transformer is devoted to series incandescent street lamps. At some points in the city four constant-current transformers of 6·6 amperes and 4,000 volts each, are devoted to street lighting, being fed by the 2,500 volts circuits. At present there are connected 86 motors with an aggregate capacity of 835 h.p. All the motors are of the induction type, three-phase, 60 ∿, and are supplied through transformers from the 2,500 volt lines. The street lighting circuit supplies 302 enclosed arc lamps, the commercial circuit comprises 50 enclosed arc lamps, and 20,000 16-candle-power incandescent lamps. At Whitney Fall, about 3,000 ft. from "The Great Fall," another station is to be erected by the same company. The article is fully illustrated. L. G.

560. *Berlin Electricity Works.* **L. Datterer.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 181–189, Feb. 8, and pp. 293–302, March 1, 1902. Paper read before the Berlin Section of the Verein Deutsch. Ingenieure.)—The author gives a historical sketch of the progress of the electricity works in Berlin, and of their contracts with the authorities. Under present arrangements the town will take over the works in 1915. The town receives 50 per cent. of the net profits after 6 per cent. has been paid on the share capital up to £1,000,000, and 4 per cent. on any excess over that amount. The works have the right of supplying the tramways at a rate not exceeding 10 pfennigs per unit. In the station in the Luisenstrasse, which stands in the heart of the town, vertical triple expansion engines with two l.p. cylinders have been employed; but in sizes of 3,000 h.p. they have been found difficult to handle in cases of repair. In other stations in the suburbs, horizontal engines are therefore preferred. The triple-expansion horizontal engines for the Oberspree station are described. They give about 3,000 h.p. at 88 r.p.m., and were built by the Görlitz Machine Company. The diameter of the h.p. cylinder is 820 mm., of the intermediate 1,250 mm., and of the l.p. cylinder 1,475 mm., the stroke being 1,500 mm. They are built for superheated steam of a temperature of 320° C., and are fully described, large drawings of the general arrangements being given. The figures obtained on test with this engine are given; running condensing with steam at a pressure of 12·3 atmospheres and a superheat of 122° C. at the high-pressure steam chest, the steam consumption was 4·05 kg. per h.p.-hour; with a superheat of 84° C. the steam consumption was 5·32 kg. per h.p.-hour; and with a superheat of 10° C. the steam consumed was 5·24 kg. Other engines were built by Sulzer for the station at Moabit of the horizontal triple-expansion type with two low-pressure cylinders. The dimensions of the cylinders are very similar to those of the above-mentioned engine. These engines are also fully described in the article, and a large plate is given showing the general construction. They give 3,000 h.p. with a cut-off at 27 per cent. of the stroke, and 4,100 h.p. with a cut-off at 50 per cent. All these engines are direct coupled to 3,000-kw. machines, generating three-phase current at 6,000 volts. The rotating magnet-inductor has a weight of 69 tons and a diameter of 7,400 mm. The armature coils are imbedded in a fixed casting weighing 70 tons, having an external diameter of 8,600 mm. and a breadth of 1,200 mm. These machines have been already described in the Zeitschr. Vereines Deutsch. Ing., pp. 13–15, and

Digitized by Google

pp. 1853–1855, 1901. The station on the Oberspree is intended to have a capacity of 47,000 h.p.; at present it contains 20,000 h.p. At Moabit, 88,000 h.p. will ultimately be installed; at present it has 14,000 h.p., but the rest is in process of erection. Two kinds of watertube boilers are used, of which drawings are given; in the one the superheaters are placed above the drum outside the boiler, in the other they are beneath the drum and above the water tubes. The former system is said to have been unsuccessful, and to have produced a saving in coal of only 8 per cent.; from the latter system a rather better result is expected. Mechanical stokers have been tried without success. The article closes with a description of the arrangements for the transport of coal. A large number of drawings are given in the article, including general arrangements of some of the stations and of the coal-handling plant. W. H. S.

561. *Western Ohio Railroad.* **D. W. Pell.** (Elect. Rev. N.Y. 41. pp. 774–777, Dec. 6, 1902.)—This railway comprises 47 miles of road, and 64½ additional miles are under construction. The power-house is constructed entirely of brick and concrete, no stone being used. The boiler-room is parallel with the engine-room, the respective widths being 45 and 52 ft., and the length 248 ft. The maximum capacity of the station is 4,000 kw., but at present only two 400-kw. sets are fixed, and two 750-kw. sets will shortly be erected. The engines are of the Cooper horizontal cross-compound condensing Corliss type, designed for running alternators in parallel with a guaranteed regulation of 1 per cent. The boiler equipment consists of eight Stirling boilers of a total capacity of 6,000 h.p. Each boiler has its own chimney, 80 ft. high by 4 ft. in diameter. The coal is hand fired direct from small trucks of 1 ton capacity, running on a narrow gauge track having turnouts, scales, &c. The pump- and condenser-room is situated in the centre of the boiler-room. The main steam header is a 16 in. heavy lap-welded steel pipe, made up in sections with pressed steel flanges shrunk on, turned, and faced. All valves over 8 in. in diameter are flanged, the flanges being tongued and grooved, and all over 8 in. are bye-passed. The generators are of the Westinghouse direct-connected three-phase type with revolving armatures running at 100 r.p.m. The magnets have thirty poles. The output of each is 400 kw., viz., 577 amperes per phase at 400 volts. The 700-kw. machines will run at 94 r.p.m., and have 32 poles. The output will be 1,083 amperes per phase, and the exciting current will be 150 amperes at 100 volts. The current is transformed up to 33,000 volts by means of oil-cooled transformers, at which pressure it is delivered to seven substations along the route. The transmission line is carried on 45 ft. poles, the tops of the poles carrying three cross arms of long leaf yellow pine. One wire is on the top of the pole, below this is a short cross-arm carrying two conductors; below these a long arm carrying four; and below these again a short arm carrying two. The three circuits are thus each arranged in triangular fashion. Each circuit is completely spiralled every mile, each set being spiralled in the opposite direction to the adjoining set, thus keeping the same phase feeders nearest to the pole. Each substation contains two 200-kw. rotary converters transforming from 390-volt three-phase to 600-volt continuous current. In the main power-house also are two 400-kw. converters supplying approximately 25 miles of the feeder system. For starting, a small induction motor is permanently mounted on the main armature shaft. The first eight cars comprise five passenger coaches and three combination passenger and luggage coaches. They are 42 ft. 6 in. in length over all by 8 ft. 8½ in. in width, the

Digitized by Google

bodies being mounted on Peckham trucks. Each carries four motors geared up to a maximum speed of 48 miles an hour, the gear ratio being 30 to 52. Straight air brakes, supplied from a motor-driven compressor, are used. Twenty-four new cars are on order, and will have "I" beam framing for the floor sills. The track is laid with 60 lb. rails, 30 ft. long, laid on 5 by 7 by 7 in. ties. The ballast is carried out 6 in. beyond the ties, and consists of rock crushed to 1½ in. ring gauge and screened, and is 8 to 12 in. thick under the ties. The ties are placed at 2 ft. centres. Some details of the overhead construction are also given. The rate of fare is two cents a mile, and the run from Linion to Minster—36·8 miles—is made in 1 hour and 46 minutes including all stops. F. B.

562. *Rodez Electric Tramways.* **H. Somach.** (Génie Civil, 42. pp. 129–132, Dec. 27, 1902.)—This tramway is used for both passengers and goods traffic, from the railway station to the town, and comprises about 1·5 miles of route. The track is of metre gauge, laid with grooved rails weighing 84 lbs. per yard and bedded on ballast, and has many sharp curves and steep gradients. The cars are of large size, with enclosed end platforms, which serve for the conveyance of luggage or for passengers standing; seats are provided for twenty-two inside, and about thirty-eight can be carried on the platforms. The bodies are mounted on bogie trucks of the maximum traction type, each equipped with one Oerlikon motor of 88 b.h.p., and the whole car weighs 17 tons loaded. Electric brakes and hand brakes are provided, and on account of the great weight of the cars and the steepness of the gradients—up to 10 per cent.—a special track brake is used for emergencies. The latter consists of a horizontal plate furnished with claws, which can be released and allowed to grip the roadway, the claws being driven into the ground by the weight of the vehicle. Two such brakes are fitted to each car, operating in one direction only, as the steep gradients all face in the same direction. This brake has been found very effectual. Small 5-ton cars for goods only are also used, mounted on four-wheel trucks with two 20-h.p. motors each. The overhead trolley system is employed, with two wires 8 mm. in diameter. The power station is equipped with two horizontal tandem compound condensing engines, running at 95 r.p.m., and driving by belt two dynamos of 100 kw. each at 470 r.p.m. There are two Cornish boilers, working at 140 lbs. per sq. in., and fitted with superheaters giving a temperature of 250° C. A Green economiser is also provided. A. H. A.

563. *Rapid Transit Power House, New York, U.S.A.* (Power, N.Y. 22. pp. 1–6, Dec., 1902.)—The power house is 586 ft. long by 201 ft. wide outside, and consists of five divisions, each comprising one chimney, twelve boilers, two engines, two feed pumps, two feed water heaters, and two condensing sets. The boilers are exceptionally large, having 6,500 sq. ft. of heating surface each, and the chimneys are supported upon columns, leaving the floor unencumbered. All the boilers are on one floor. The flues are of steel lined with brick, and the economisers are fixed above the boilers. The chimneys are of brick 15 ft. in diameter inside, and 225 ft. high above grate level. The pumps are arranged between the boiler- and engine-houses, with the pipe chamber above them. The piping is subdivided on account of its large size. The engines are of the Manhattan type, of 8,000 h.p. each, with horizontal high-pressure and vertical low-pressure cylinders, 44 and 88 in. in diameter. One engine is replaced by three 1,250-kw. Westinghouse steam turbo-alternators, generating current at 11,000 volts, for lighting the subways and stations. There are also

Digitized by Google

two steam-driven 250-kw. exciters and three motor-driven sets of the same output. The condensers are of the barometric type, with dry air pumps; the condensers for the turbines, however, are of the surface type, so that the condensed steam, which is free from oil, can be used for boiler feeding. The article is accompanied by drawings. A. H. A.

564. *The Tramway System of Bolton.* (Tram. Rly. World, 18. pp. 29–41, Jan., 1903.)—This is a profusely illustrated article describing the Bolton tramways and power-house, and giving, amongst other details, particulars of the various changes in track construction from the earliest horse car practice, as well as useful financial details as to capital, expenditure, depreciation, &c. The new rails on the straight are in 60 ft. lengths, 7 in. deep, and weigh 94 to 98 lbs. per yd. For curves the rails weigh 105 lbs. per yd. The fishplates weigh 79 lbs. per pair for the straight track, and 58 lbs. per pair for curves; sole plates 2 ft. × 11 in. × ½ in. are also used. The rail lengths being 60 ft., they are anchored in the centre by means of 2 ft. 6 in. lengths of old rail inverted and laid at right angles, let into the concrete foundations, and secured thereto by 3 to 1 concrete.

The main car-shed for 80 cars is 300 ft. long by 90 ft. wide in two spans, and 24 ft. high to springing of roof trusses. The walls are faced inside with a high dado of white glazed bricks, and the sheds costs £142 per car. In the repair shop there is a special machine for rolling new dash fronts or for smoothing out fronts that have been damaged in collision.

The overhead construction is largely of side brackets, the poles being of three-section type, some of the bracket arms reaching a length of 24 ft. On the extensions, centre poles and $\frac{7}{16}$ span wires are used, with the poles all in one piece. The greatest distance between centre of car and centre of trolley wire is 11 ft. The cars are of various types, but the majority are single-truck double-deck, with reversed stairways, carrying 22 inside and 34 out. Brill trucks and 25-h.p. motors are used. The outside seats are of the reversible garden type, with McDougall's never-wet seating. All the better known lifeguards are in use, the Tramways Committee not having permanently adopted any particular type. The wheels are steel-tyred on wrought-iron centres, as it has been found that chilled cast-iron wheels chip badly, and are worn out after a run of 30,000 miles—that is, about a year's run. The number of car miles run during the year ending March, 1902, was 1,705,000, and the average number of miles run per car per annum was 34,480, or 91·8 miles per day. The number of units used was 1,999,640, and the units per car per day were 107·4, or 1·17 per car mile. This figure of 1·17 is perhaps higher than it should be, but it only serves to prove that the basis from which tramway accounts are largely made out, that is per car-mile, may be misleading, as the speed at which the car-mile is run is not taken into consideration, neither is the type of cars. The traffic commences at 4.30 a.m., and continues to 12.30, and is worked in two shifts. The receipts per car-mile for the last year were 10·78d., the working expenses 6·95d., interest and depreciation 3·44d., leaving a profit per car-mile of 0·48d. The power-station has eleven Lancashire boilers, capable of evaporating 30,000 lbs. of steam per hour. The generating machinery is partly alternating and partly continuous, and includes two 1,500-h.p. slow-speed steam dynamos. The supply in the centre of the town has in the past been alternating, but is being changed over to continuous. The total cost of producing electricity for the year 1902 was 0·959d. per unit, said to be the lowest of any station in this kingdom.

E. K. S.

Digitized by Google

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

565. *Long-distance Electric Railroading.* **L. Duncan.** (Technology Quarterly, 15. pp. 317–325, Dec., 1902. Paper read before American Soc. Arts, Oct. 9, 1902.)—A brief history of the development of electric traction is given, followed by recent proposals to solve the problem of long-distance transmission. Owing to the increase in the capacity of cars and trains, amounting, on the Pennsylvania Railroad, to 100 per cent. and 75 per cent. respectively during the last twenty years, a system of transmission with continuous-current motors at 500 to 600 volts is not now applicable. The alternating-current system in use on the mountain railways of Switzerland is shortly described. A modification of the *Ward-Leonard* system with a single-phase motor coupled to a C.C. dynamo is being experimented upon at the Oerlikon Works. Another system, suggested by Mr. Arnold, is to use a single-phase motor in conjunction with an air compressor. A system installed by the Westinghouse Company on a road between Baltimore and Washington uses a single-phase current at 16⅔ periods, the motors being of the laminated field type with commutators wound like a C.C. series motor. The three-phase system, as used in Switzerland, does not solve the problem; the cars are small, the voltage is limited to 750, and the distances are short. The Lecco railway in Italy more nearly fulfils the conditions of long-distance railroading. This road is 60 miles in length, and is equipped on the Ganz three-phase system. Power is transmitted, from a waterfall, at 20,000 volts to substations, where it is transformed to 3,000 volts. Two overhead wires are used, and the rails form the third conductor. Details of the equipment are given, and the system is adversely criticised. The other systems named are examined critically, and the author sums up by saying that no method has yet been in successful practical operation that solves the railway problem. F. B.

566. *The Cost of Stopping Tramcars and Trains.* **R. W. Western.** (Tram. Rly. World, 12. pp. 738–740, Dec., 1902.)—The author calculates that the mechanical energy required to run a car one mile is equal to that absorbed by fourteen stoppages, so that if the car stops four times in a mile, and the operating costs amount to 4d. per mile (wages excluded), the sum to be debited to stopping should be 0·22d. In this calculation it is assumed that the weight of the car is 6 tons, and that its speed is 10 miles an hour. Taking the concrete case of the City and South London Railway, it is calculated that the cost of stopping the train is 0·747d. These figures do not include losses due to standing. Each train costs 6·86d. per minute of actual running, so that the loss of 17½ secs. at each station amounts to 1·988d. From the figures of the Liverpool Corporation Tramways it is calculated that £35,000 is annually expended in stopping the cars. A passenger who stops a 6-ton car moving at 10 miles an hour causes an expenditure of energy of 45,000 ft. lbs. If he stops it both on entering and leaving, this amount is doubled, and as only 6,600 ft. lbs. are required to carry him a mile, it follows that he could have been carried over 12 miles for the same expenditure of energy as he demanded in stopping the car twice. The suggestion is to accentuate the use of regular stopping-places or to charge a passenger extra for stopping specially at any other place.

F. B.

---

[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

Digitized by Google

567. *Multiple Unit, Voltage Speed Control for Trunk Line Service.* **H. Ward Leonard.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1581–1584, Dec., 1902.)—This is a description of a single-phase, high-tension, alternating-current system for operating trunk line railways. A single-phase synchronous motor is carried on the locomotive. This is coupled direct to a continuous current dynamo and exciter. The individual motor armatures on the train are connected to the leads from the continuous-current dynamo, the magnets being all separately excited by the exciter. A field reversing switch is provided in the dynamo field circuit. By manipulating the dynamo field rheostat, the current through the motor armatures necessary to obtain the required tractive effort can be obtained at any desired voltage, from the lowest to the full speed voltage, in either direction. A perfectly smooth and rapid acceleration can thus be obtained with minimum energy from the source of supply. The author claims twelve advantages for his system. A diagram of connections is given. F. B.

568. *Recuperative Braking of Electric Automobiles.* **W. A. T. Müller.** (Centralblatt Accumulatoren, 8. pp. 4–6, Jan. 1; 32–33, Feb. 1; 41–45, Feb. 15; and pp. 53–56, March 1, 1902.)—This series of articles consists of a long and detailed mathematical investigation of the conditions under which the motor of an electromobile acts as a generator when the vehicle is running down-hill, or at other times when a braking effect is required, and of the amounts of energy so returned to the battery, taking into account the characteristic curves of the types of motors and storage cells usually employed. The author considers that a compound machine, with its series winding capable of being cut out of circuit at will, is the only kind that can be practically utilised for the purpose, but his final conclusion is that, except in special cases, it is better to employ a series motor, and abandon recuperative braking altogether. E. J. W.

569. *Schuckert Co.'s Postal Delivery Electromobile.* **W. A. T. Müller.** (Motorwagen, 5. pp. 846–848, Dec. 15, 1902.)—This is a description of a light electrically-driven delivery tricycle for postal purposes. The tricycle, which is of the front-steering type, is fitted with an electric motor slung from the rear axle, and driving both rear wheels through a speed-reducing and differential gear of special construction (not described). Power is obtained from a storage battery consisting of 80 Tudor cells, type A 55, situated in a rectangular box, the top of which is fitted with a railing, and forms the parcel carrier. At the front of this is situated the driver's seat, inside of which is placed the controller and reversing switch, the former being operated by a pivoted side handle. The capacity of the motor is 1·5 h.p. at a speed of 1,200 revolutions. The total weight of the vehicle is 700 kg., and the load which it is capable of carrying is 50 kg. normal and 100 kg. maximum. It can also, however, be arranged to carry as much as 150 kg. The normal running speed on a level road is 15 km. per hour. The controller has five forward speed, two reverse speed, and two brake, notches, and is fitted with a magnetic arc blow-out. The speed control is effected by parallel and series grouping of various numbers of cells, and the braking is accomplished by connecting up the motors as generators, through a resistance and on short circuit. A hand brake is also fitted, which operates band clutches on the rear wheel hubs. The vehicle has been put into service in Munich. On week days fifteen letter-collecting journeys require to be made, of an average distance of 6·5 km. each, so that the daily performance of the vehicle is about

Digitized by Google

100 km. The battery is designed to have sufficient reserve charge after a day's run not to interfere with its efficiency. At the charging station, which is supplied from the town's mains at 220 volts, three sets of 80 cells each are kept for each vehicle, and the exhausted set is charged, after the day's run, in series with the other two directly across the mains, a fully charged set being used the following day. The average rate of discharge of the cells is 140 watt-hours per km., at a cost of approximately 3d., calculated according to the cost of supply in Munich. The article, which also gives particulars of tests of the motor, is accompanied by photographic reproductions and dimensioned illustrations of the vehicle, and also by a diagram of the controller connections. J. G.

570. *Electric Launches.* **C. Dreihardt.** (Centralblatt Accumulatoren, 3. pp. 273–275, Nov. 1, and pp. 286–289, Nov. 15, 1902.)—A description is given of three electric launches equipped by the Accumulatoren-Fabrik Hagen and exhibited on the Wannsee in 1902. The following are the principal dimensions of the boats :—

	Germania.	*Wannsee.*	*Havel.*
Length overall	19·5 m.	9·5 m.	8·8 m.
Draught	0·885 m.	0·9 m.	0·8 m.
Displacement	17·5 tons	3·65 tons	3·2 tons
Motor	60 h.p.	4 h.p.	4 h.p.
Weight of battery	7 tons	1·7 tons	1·7 tons
No. of cells	80	80	80
Ampere hours	450	120	120
Speed km. per hour	9·5 to 17	7·5 to 11·5	7·5 to 11·5

Series motors are employed, and the controller groups the magnet windings in series or parallel, as well as the two halves of the battery. The *Germania* ran 200 km. in 22 hours with one charge. A. E. L.

571. *Semaphore Signals on Bristol Electric Tramways.* **C. Challenger.** (Tram. Rly. World, 18. pp. 63–64, Jan., 1903.)—Three lines meet at the lower end of Perry Road, and the cars from and to the latter have to negotiate both a severe curve (in fact, a sharp corner) and a steep grade at the junction with Colston Street. At the edge of Perry Road, just above this junction, a signal box and four semaphores have been instituted. They are worked mechanically, as well as the permanent way points, by a man in the box, who can, from his position, view the three routes. The cars of the two services are timed to pass the junction alternately. By day, the semaphore to be observed by the driver of up and down cars is distinguished by a broad white line painted across it, and by night a red light indicates "Stop," and a green light "Proceed, line clear." The normal position of signal at "line clear" is found to save labour and proves satisfactory, 600 cars passing the junction daily. The overhead point, of special design, is operated by the trolley arm, and is due to W. H. Munton, engineer of the outside electrical department. Details of this are not given. E. O. W.

572. *Electric Signalling for Railways.* (Electrician, 50. pp. 547–550, Jan. 23; and pp. 592–594, Jan. 30, 1903.)—The article describes several systems previously noticed in some cases in these Abstracts. In the Hall system coloured discs are used instead of semaphore blades. The disc, which is about 1 ft. in

Digitized by Google

diameter, is made by stretching coloured silk over an aluminium wire frame, lightness of moving parts being of prime importance in this pattern. This disc is placed on one end of a lever, while the other end carries a small disc of coloured glass. The lever is mounted, near its centre of gravity, upon the armature of an electro-magnet of about 85 ohms resistance. The whole apparatus is enclosed in a large weatherproof case. When the magnet is not excited, the silk disc hangs behind a round glass window in the case, while at the same time the coloured glass covers a small window just above the first one, and in front of the lamp which gives the night indication. When the magnet is energised, the lever turns upon its axis until the silk disc is raised away from the window, and the coloured glass moved away from the lamp. This is the clear position, and shows a white background behind the window in the place of the coloured silk. When the lever reaches the clear position, the 85-ohm magnet is cut out of the circuit, and one of 500 ohms is cut in.

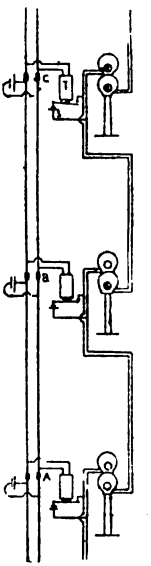


FIG. 1.—CIRCUITS FOR HOME AND DISTANT NORMALLY CLEAR SIGNAL.

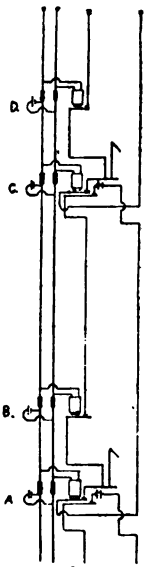


FIG. 2.—A CIRCUIT FOR THE OVERLAP BLOCK.

This high-resistance magnet is sufficient to hold the signal in the clear position. These signals are mounted on iron or wood masts, with the red above the green, if home and distant are on the same pole. A form of track circuit with Hall disc signal is shown in Fig. 1. A, B, C, are block stations. The rails are bonded except at the points marked black, where the points are insulated. On a train or any pair of wheels passing over the track, the current from the track battery will be short-circuited, and the armature of the track relay will fall, thus operating the signal. It becomes restored again when the wheels pass beyond the next black station. Fig. 2 shows an arrangement which is sometimes used in the place of a distant signal or caution blade of a semaphore. The signal at station *A* does not go to the clear position when the train passes station *C*, but only after it has passed *D*. The distance between *C* and *D* is sufficient for a train to stop when running at full speed. A driver finding the signal at *A* in the danger position, knows that there

Digitized by Google

is a train somewhere between *B* and *D*. This overlap block is especially useful in single-track blocking. The Gray signal uses the same kind of track circuit as that in Fig. 1; a small electric motor of about $\frac{1}{10}$ h.p. moves the three-position semaphore blade to the caution and clear positions respectively. The mechanical and electrical parts are enclosed in a waterproof iron box which rests on the ground or on a bridge, and supports the mast of the signal, which is a steel tube within which the up and down rod of the signal moves. The wires at A are from the track relay and signal battery. When the track relay closes, the current from the signal battery flows from A to the contact maker B. This contact maker is a spring which presses against a metallic slider C D. Part of the current passes through the spring E, through the magnet S, and thence back to the battery; another part of it goes through the spring F and starts the motor M. The slider C D and the magnet S (which has flexible connections) are fastened permanently to the lower end

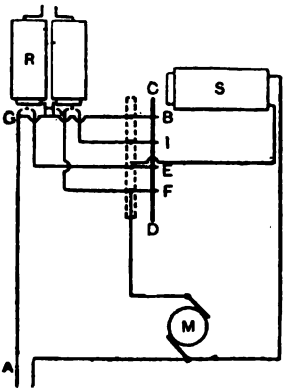


FIG. 3.—CIRCUITS OF THE GRAY ELECTRIC SEMAPHORE MECHANISM.

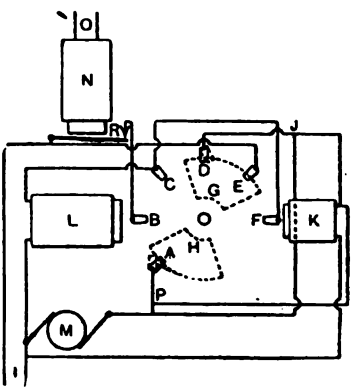


FIG. 4.—CIRCUITS OF PENNSYLVANIA IMPROVED ELECTRIC SEMAPHORE MECHANISM.

of the signal rod, which is hollow and fits like a sleeve over a short lifting rod. The lower end of this lifting rod is a rack operated by a pinion from the motor through a train of gear wheels. The electric circuits in the box are shown in Fig. 3. An improved Gray signal is shown in Fig. 4. The two most important contacts, A and D, swing on pivots as the quadrant passes through them into the position shown by the dotted lines. When the quadrants finally leave them they spring back to the normal position, preventing sparking by giving a quicker and much wider break than would occur otherwise. This signal is especially economical in yards where there is much switching, since, if a switch be opened in the second block ahead, the blade will go at once to the caution position and be caught there. In the Gray signal it would first go to the stop position, when the motor would start and move it to the caution position. This new signal has a liquid dash-pot which makes it work very smoothly. E. O. W.

573. *The Block System of Middleboro' and Buzzards Bay Street Railway.* (Street Rly. Rev. 18. pp. 1–8, Jan., 1908.)—Single-track sections between turnouts are blocked in the following manner. There are three boxes on three adjacent poles at each end of each block. Each box contains one lamp, and the six lamps are all in series on a single wire. On the middle pole of each

Digitized by Google

group of three poles is the switch, which is manually operated by the conductor. On arriving at a turnout, the driver has one lamp (in the "indicator" box) facing him, and thus is able to see whether the section ahead is already occupied by a car coming from the opposite end, whose conductor will have switched on all the lamps from that end. If the lamp in the indicator box is not alight the car may proceed. The conductor of this car then switches on five of the lamps, two at his, and three at the further end of the section, and the car is then in possession of this section. The sixth lamp, in what is called the "tell-tale" box, is extinguished by the operation of the switch, and indicates to the driver that the conductor has cleared the section which has just been left behind. The lamp in the switch box shows the conductor that the circuit is in order. A car must not proceed if the lamps do not light when switched on. When quitting a section, the conductor turns off the lamps behind, thus clearing the section for the next car. The regulations provide for cars following each other on a single-track section, but the conductor of the first car is held responsible for the block, cutting the switch in before entering the same, and stopping his car at the other end until all the cars following are in sight and close behind, before throwing the switch clearing the block. To obtain orders in circumstances out of the ordinary, such as failure of lamps, or passing cars not being punctual to scheduled time, a telephone circuit is available for communication with the superintendent's office. In line with the general system of precautionary methods, the approach to all dangerous points, blind curves and unusual grades is indicated to the motorman by a system of striping the poles. On the fourth pole from the dangerous point in both directions are painted four broad stripes diagonally across the side of the pole where the headlight will shine on them as the car approaches. On the third pole from the danger point are painted three stripes; on the second, two; and on the first, one. The motormen are hereby enabled to compute the distance to the danger point, and are instructed to bring the speed of their cars down to four miles an hour as soon as the four stripes become visible. This has been found very beneficial, particularly during foggy weather and snowstorms, and also at night.

E. O. W.

ELECTRIC LAMPS AND LIGHTING.

574. *Electric Lighting of Trains.* **C. Jacquin.** (Soc. Int. Élect., Bull. 2. pp. 388-876, May, and pp. 485-524, June, 1902.)—The various methods that have been proposed for the lighting of trains by electricity are described and discussed, and a synoptic table is added. The following, abstracted from the latter, shows that the electrical method is rapidly extending:—A. By accumulators alone. I. By one or two batteries only.—Danish State Railways 700 vehicles. II. By independent batteries on each coach. *a.* By removable batteries charged at certain stations.—Jura Simplon Railway 668 vehicles, Central Swiss Railway 139, Gothard Railway 20, Berne to Neuchatel Railway 65, German Postal Service 15,000, Bavarian Postal Service 40, Austrian Postal Service 50, French Postal Service 26, Eastern French Railways 154, Hungarian Railways 125, North Austrian Railways 65, Austrian State Railways 20, Mediterranean (Italian) Railways 118, Adriatic (Italian) Railways 80, Bavarian State Railways 85. *b.* By batteries charged on the trains.—Northern French Railways 295 vehicles, French Northern Postal Service 9, French Railways 405, Roumanian State Railways 88. B. By dynamos and accumulators. III. Lighting of the entire train by single generator. *c.* By dynamos driven from the axles.—London and Brighton Railway 271 vehicles, English Great

Digitized by Google

Northern Railway 90, Austrian State Railway (system Dick) 11, system Stone in Germany 1 or 2 trains on small railways, system Vicarius in France 1 train (projected). *d.* Dynamos driven by a special motor. K1 with accumulators. Boiler, engine, cells in a waggon.—Imperial Russian trains, Imperial Austrian trains. Engine, dynamo, and cells in a waggon; steam furnished by the locomotive.—Several American trains. K2. Without accumulators. Boiler and Laval turbine in a waggon.—Several Russian trains and the Trans-Siberian Railway. Petroleum motor and dynamo in a waggon.—Certain State Railways. Engine and dynamo on the locomotive, which latter furnishes the steam. IV. Each carriage with means for independent lighting. Stone System.—England and other countries 3,000 vehicles, Belgian State 820, Compagnie des Wagon-Sits 180, Jura-Simplon 26, German 20, Western France 14. Moscowitz System.—A certain number of American and English vehicles. Vicarino System. (1) With a single battery.—Western France 28 vehicles, French State 33, Central France 5, Madrid 15, Compagnie des Wagon-Lits 5 dining cars in Spain, Bavarian Postal Service 1 vehicle. (2) With double battery.—French Postal Service 10 vehicles, Eastern France 10. Auvert System.—French railways, 59 vehicles. Dick System.—Austrian 15 vehicles. Kull System.—Swiss 27 vehicles. The author mentions several systems he has proposed. They fall under Section IV. W. W. H. G.

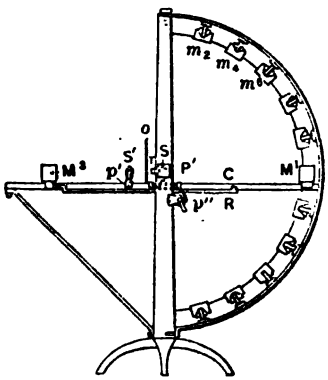
575. *The Osmium Lamp.* **G. Gillon.** (Soc. Belge. Élect., Bull. 19. pp. 715-718, Dec., 1902.)—Three specimens of the lamp were sent to the author for examination; of these, two were broken in transit. The filament, which is 25 cm. long and 0·09 mm. in diameter, carries a current of 1 ampere at a pressure of 87 volts. The high temperature of the filament causes it to expand, and it is caused to slide in two supports, which tend to keep it in position; and the lamp is consequently said to be only suitable for suspension in a vertical position. It is being sold by the Auer Company in Berlin for 9s., with an allowance of 9d. for a burnt-out lamp. A curve is given showing the effect of variation of voltage on the c.p. The mean horizontal c.p. at the normal voltage is 25, and the mean spherical c.p. is 16·5. It takes, therefore, 2·24 watts per spherical c.p. as compared with about 4·5 watts for an ordinary incandescent lamp. According to the statements of the inventors, the lamp is said to last 500 hours. W. H. S.

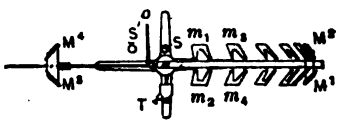
576. *An Integrating Photometer for Incandescent Lamps.* **C. P. Matthews.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1465–1476; Discussion, pp. 1500–1509, Nov., 1902.)—This photometer can be applied to various purposes. It was, however, specially designed to enable the mean spherical candle-power to be determined at one reading. Its general construction may be described as follows, in connection with the appended diagram.

S′ is the standard lamp, S is the lamp to be tested, the two being separated by an opaque screen. S can be rotated, if necessary. The light from S′ reaches the photometer P after reflection from the mirrors M_4 and M_3. Similarly the light from S is reflected to the photometer by means of the mirrors m_1, m_2, m_3, &c., arranged as shown round the circumference of a semi-circle. The total illumination which reaches the photometer from the source S is shown to be proportional to the mean spherical intensity of S. It is, therefore, necessary to balance this illumination against that received from the standard in order to determine the mean spherical candle-power of S. This is done by an arrangement of rack and pinion, which allows the observer to move the mirrors M_4 and M_3 until a position is reached in which a balance

Digitized by Google

is obtained. Errors, however, are liable to arise owing to the fact that the mirrors may have unequal reflecting powers, and also to the fact that the illumination of the photometer screen, due to any particular set of mirrors, does not vary exactly with the cosine of the angle of incidence. Diagrams are given showing the percentage variation from the cosine relation with different screens. The plaster of Paris screen of the Lummer-Brodhun photometer obeys the cosine law exactly up to an incidence of 50°; with a Bunsen screen, made of drawing paper, the departure from the cosine law is as high as 15 per cent.





at 75°; with a screen of glazed writing paper the deviation is 25 per cent. at 75°. All these errors are eliminated in the instrument by an arrangement which permits a radial adjustment of each pair of mirrors. Each mirror bracket is provided with two pins. These pins extend through the frame of the ring in a radial direction, and thus each pair of mirrors is capable of initial adjustment with a view to the correction of the errors above mentioned. For the measurement of the mean horizontal candle-power, all the mirrors except the four horizontal ones are covered by suitable screens, while the lamp under test is rotated at a convenient speed. The author also describes the following operations, viz., the determination of candle-power in vertical planes, the standardisation of glow lamps, the measurement of mean spherical intensity, the direct measurement of the spherical reduction factor, the checking of the horizontal mirror constants, and the checking of the adjustment of the circular mirror system. W. H. S.

REFERENCES.

577. *Measurement of Power in Unequally-loaded Three-phase Circuits.* **R. Arno.** (Soc. Int. Élect., Bull. 2. pp. 813–827, Dec., 1902.)—The paper contains a general description of the principles involved in measuring the power of such circuits. Illustrative results are given. [See Abstract No. 500 (1902).] E. S. A. R.

578. *The New Power Plant for the Assabet Woollen Mills, Maynard, Mass.* (Eng. Record, 46. pp. 314–317, Oct. 4, 1902.)

579. *Improvement of the Load Factor.* (West. Electn. 31. pp. 294–295, Oct. 25, 1902. Discussion at the meeting of the Ohio Electric Light Association at Columbus.) —A discussion of methods of increasing the business of a central station. One of the speakers advocated the distribution of exhaust steam for use in radiators, and gave figures showing the profits to be realised from this side of the business, which he recommended more particularly in the case of small towns. W. H. S.

Digitized by Google

580. *Tramway Power Stations.* **M. Eisig.** (Elektrotechn. Zeitschr. 23. pp. 588–593, July 3, and pp. 607–611, July 10, 1902.)—The author considers generally questions affecting the design and working of such stations. His remarks are divided into sections under the headings of boilers, steam engines, gas engines, turbines, size and number of the units to be installed, accumulators, substations, and automatic cut-outs. W. H. S.

581. *European Practice in Three-phase Traction.* (Amer. Inst. Elect. Engin., Trans. 19. pp. 1018–1033, June and July, 1902.)—Discussion on paper by C. L. de Muralt [see Abstract No. 122 (1903).] G. W. DE T.

582. *Railway Motors and Electric Railroads.* (Amer. Inst. Elect. Engin., Trans. 19. pp. 1149–1161, Aug.–Sept., 1902.)—Discussion on papers dealt with in Abstracts Nos. 1635, 2341, 2342, 2343, and 2344 (1902). G. W. DE T.

583. *Voltage Drop in Electric Tramway Rails.* **R. Ulbricht.** (Elektrotechn. Zeitschr. 23. pp. 720–722, Aug. 14, 1902.)—This is an investigation of the voltage drop in the track rails of electric tramways. Sketch maps of the tramway systems of Dresden and Leipsig are given, and special cases are worked out in much detail. E. K. S.

584. *Automobile Repair Trolley for Electric Tramways.* **L. Fournier.** (Locomotion Automobile, 9. pp. 678–681, Oct. 23, 1902.)—The paper describes a trolley consisting of a 12-h.p. Delahaye car filled with all the requisites for repairing and inspecting an overhead electric tramway system. Some figures are given comparing the cost of the motor trolley with other systems of effecting repairs. C. R. D'E.

585. *Electrolysis by Earth Returns.* **F. L. Johnson.** (Power, N.Y. 21. p. 5, Dec., 1901.)—Notes on corrosion of steam plant caused by using water pipes as an earth, or an earthed plate near the plant. W. R. C.

586. *Electrolysis by Earth Returns at Erie, Pa.* (Eng. Record, 45. pp. 223–224, March 8, 1902.)—An account of measurements by A. A. Knudson, showing the serious effects of bad bonding. W. R. C.

587. *Electrically Welded Rail Joints and Bonds.* (Street Rly. Rev. 12. pp. 827–828, Nov., 1902.)

588. *Manchester and Liverpool Mono-rail Railway.* (Tram. Rly. World, 12. pp. 599–607, Nov., 1902.)—A description of the proposed construction of this line, including the permanent way, rolling stock and electrical equipment, braking, signalling, &c. [See also Abstracts Nos. 307, 308, 1440 (1901), and 2351 (1902). W. H. S.

589. *The Aberdeen Cable Subway and Outfall Sewer.* **G. R. G. Conway.** (Feilden, 7. pp. 492–504, Dec., 1902.)

590. *Water Power in Electrical Supply.* **A. D. Adams.** (Cassier, 23. pp. 326–331, Dec., 1902.)—The author discusses the conditions determining the advisability of utilising water power in cases where the supply is, during some portions of the year, insufficient for the required output, and an auxiliary steam plant must therefore be employed. The figures given are stated to have been obtained from plants in operation. G. W. DE T.

Digitized by Google

591. *Doncaster Tramways.* (Elect. Engin. 29. pp. 798–803, June 6, 1902.)—A brief general description. W. H. S.

592. *Hastings Electricity Works.* (Electrician, 50. pp. 379–382, Dec., 1902.)—A description is here given of some experiments carried out at Hastings to demonstrate the action of the Andrews "discriminating" transformer, choking coil, and cut out for the protection of duplicate feeders. The action of the rotary synchroniser, the "sparklet" fuse, and the "horn" type circuit breaker was also demonstrated. Photographs of the interiors of the substations and of the Parsons turbo-alternator are also given, together with a diagram of the substation connections. [See also Abstract No. 2105 (1900).] F. B.

593. *Tramway Rolling Stock.* **R. H. Simpson.** (Tram. Rly. World, 12. pp. 415–420, Sept.; 510–518, Oct.; 635–641, Nov.; 723–727, Dec., 1902; and 13. pp. 59–63, Jan., 1903.)—This is a series of articles dealing with the various types of tramway rolling stock. They contain a number of large scale drawings of important details, and tables giving the principal dimensions of cars of different types. G. W. DE T.

594. *Accumulator Batteries in Tramway Work.* **G. Cristoforis.** (Elettricista, Rome, 11. pp. 287–294, Dec., 1902.)—A diagram is given illustrating the equalising effect of accumulator batteries at considerable distances from the generating or transforming stations, and inserted in simple derivation between the main line and the return. Applications to particular cases are discussed. The use of such batteries may greatly extend the radius of the district served. A. D.

595. *Illumination.* **D. Burnett.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1477–1482; Discussion, pp. 1500–1509, Nov., 1902.)—Some notes on the question of illumination. The author considers the effect produced by an artificial light, and points out that the illumination upon a lighted surface is largely increased by the diffusion of light from other reflecting surfaces. W. H. S.

596. 30,000-*volt-power Transmission in Europe.* **H. Behn-Eschenburg.** (Zeitschr. Elektrotechn., Wien, 20. pp. 633–638, Dec. 21; and pp. 649–652, Dec. 28, 1902.)—The original 15,000-volt transmission from Hochfelden to Oerlikon has now been changed over to 30,000 volts. R. C. R.

Digitized by Google

TELEGRAPHY AND TELEPHONY.

597. *Alternate Currents for Land Telegraphy.* **E. F. Northrup.** (Elect. World and Engineer, 40. pp. 740–743, Nov. 8; 779–781, Nov. 15; 820–823, Nov. 22; 857–859, Nov. 29; 897–898, Dec. 6; and pp. 950–952, Dec. 13, 1902.) —The author reviews the work done by H. A. Rowland and others, which led to the Rowland multiplex printing telegraph, and discusses the advantages of the use of alternating currents for land telegraphy. He considers—(1) What is the greatest practical length of line over which it is possible to transmit clear signals, when duplexed, or not duplexed. (2) In what manner the construction of present lines can be modified so as to increase the distance of clear signalling. (3) In what manner, and how rapidly, signals can be impressed upon the line current. In order to limit the problem to a practical case he premises that, for clear signalling, sufficient current must be received at the distant end to maintain in rapid vibration the tongue of a polarised relay. This minimum current is assumed to be about 25 milliamperes. If the tongue of such a relay can be kept by the alternating line-current in continuous rapid vibration, perfect synchronous motion can be maintained between the moving apparatus at the two ends of the line, signals can be transmitted with great rapidity, and can be translated automatically into any desired form, such as Morse signals or printed characters. The mathematical treatment of the subject here followed is similar to that employed by Steinmetz to solve the problem of power transmission over long lines by alternating currents. In this way the constants of the line are calculated and curves are drawn giving (1) the e.m.f. at all points along the line; (2) the relative value of the current at all points along the line; and (3) the phase, in degrees, of the e.m.f. at all points of the line, its phase at the beginning being taken as the zero vector; (4) the phase, in degrees, of the current at all points of the line, the phase of the e.m.f. at the beginning of the line being retained as zero vector. The current is shown to have decreased to half value in about 194 miles, and to one-tenth at 648 miles, of ordinary land line. At 1,515 miles the current is 1/117 of its initial value. In these cases the ohmic resistance is taken at 2·672 per kilometre, the insulation resistance at 1 megohm per kilometre, the self-induction at 0·0018 henrys per kilometre, and the capacity at 0·0062 mfds. per kilometre. Taking into account the practical limits of the relay, and assuming the line insulated as above described, the author concludes that 648 miles is about the maximum distance over which it would be practicable to work duplex through a No. 9 copper wire, with alternating currents of frequency of 100. He is convinced that automatic relaying is perfectly feasible with alternating-current telegraphy. Working simplex on an artificial line, the author has transmitted and printed 160 words per minute, over what he considers to be the equivalent of 1,200 miles. He concludes that it would be practicable to signal simplex over 1,500 miles through a No. 9 copper aerial. There are two general ways in which a signal may be impressed upon the alternating-current system. The first is to modify a particular half-wave by a direct-current signal. The second method is to form the signals from a particular combination of modified half-waves. The cutting-out and the reversing of half-waves are the only two kinds of modification of the current which, so far, have been found of

Digitized by Google

practical importance. It is desirable that the current and the e.m.f. shall be in phase at the point of the line where the current is so modified. Otherwise there is sparking at the line contacts. By inserting in series with the line the proper amount of self-induction, it is easy to bring the current and e.m.f. exactly into phase at any point of the line. To cut out a single half-wave of the alternating current, a device is employed which breaks the circuit when the current is passing through zero, and completes it again after the time of a half-wave has elapsed. There is another method of doing this, in which a revolving brush is raised clear of a fixed commutator for the time corresponding to the width of one commutator bar. Or again, the secondary of a transformer may be connected between the end of the line and earth. Corresponding with this secondary are two primaries wound in opposite directions. Either of the primaries, or both of them, can at any instant be connected to the generator by means of a rotating switch, in any desired combination. There is also Rowland's well-known method of grouping the waves; this method and Rowland's devices for attaining synchronism are carefully described. [See Abstract No. 2059 (1901).] Experimenting with an artificial line, the author finds that it is easier to obtain clear signals over great lengths than over short ones, when alternating currents are used, for with the longer lines the "tailing out" of the wave helps to make the relay tongue stick tight, and so to operate with more certainty the local relays. As the result of other experiments, the author concludes that, in the case of transmission by alternating currents, disturbances such as those arising from faulty insulation, earth currents, and trolley currents are less serious than in the case of ordinary circuits with direct currents. To eliminate the effect of such disturbances, the line is divided into sections, each section acting inductively upon the next, through a transformer. At each intermediate transformer, one end of each primary and one end of each secondary are connected together and to earth; the other ends are connected respectively to the lines of the two sections. With alternate-current telegraphy it is not necessary to have more than one source of current to operate a system worked from a central telegraph office. To effect this economy, Rowland introduced the "reflected wave system." The author discusses this system. In conclusion, the author describes how, by means of the alternating-current synchronous system, eight messages can be sent over a long line at the same time. R. A.

598. *Lightning-Protectors for Telephone Lines.* **A. Franke.** (Elektrotechn. Zeitschr. 28. pp. 1046–1049; Discussion, pp. 1049–1050, Nov. 27, 1902. Paper read before the Elektrotechnische Verein, March 25, 1902.)—In the scheme of protection here adopted, the lines where they enter a station each pass through two fuses arranged in series, the outer one melting with a comparatively heavy current, *e.g.*, 8 amperes, and the other with a lower current, *e.g.*, 3 amperes, and between these fuses is connected one pole of a lightning-protector, the other pole of which is connected to earth. The fuses are of the Bose type, in which the current heats fusible metal solder holding in tension two metal springs arranged in a glass tube, so that the circuit is broken when the springs are released by the melting of this solder. In order to protect the persons and instruments at the station against the effects of a 500-volt current (introduced by contact of the telephone line with a wire transmitting current, *e.g.*, for traction purposes), the lightning-protector must be capable of working at about 400 volts. These lightning-protectors each consist of two blocks of carbon having parallel ribs of V-shaped cross-section, the

Digitized by Google

ribs on one block being arranged at right-angles to those on the other block. On the block in which the ribs are transverse to the length of the block, spaces are formed beyond the end ribs; and the other block, having longitudinally extending ribs, is made somewhat shorter and narrower than the former. The pieces of sheet insulating material at the ends have the breadth of the larger block. By this means the insulation-resistance is not easily destroyed by conducting dust-particles lying along the edges of the insulation. The distance apart of the edges of the ribs is finally adjusted by bringing them together, with a piece of sheet steel 0·08 mm. thick between them, and then securing them by cement, the steel gauge being afterwards removed. Various forms of these protectors combined with fuses are described and illustrated. In the discussion, **Strecker** stated that he had already used similar arrangements in which there was, in addition, a coarsely-adjusted lightning-protector (2 mm. air-gap) arranged outside the heavy current fuse. The **Author** stated, in reply, that he had also used a similarly-arranged coarsely-adjusted lightning-protector. C. K. F.

REFERENCE.

599. *Baudot Multiple Type-printing Telegraph.* (Elektrotechn. Zeitschr. **23**. pp. 1006–1008, Nov. 13, 1902.)—A description of this apparatus is given in Abstracts Nos. 631 (1902) and 1461 (1901). The present account shows the method of assembling the various parts of the apparatus and relays, and includes a complete diagram of connections for the latest form of instrument. [It may be of interest to point out that the Baudot type-printing telegraph, which is probably the most perfect piece of mechanism of its kind, is now installed at the British Post Office, St. Martin's le Grand.] R. A.

600. *Analysis of Wireless Telegraph Systems.* **A. F. Collins.** (Elect. World and Engineer, 41. pp. 11–13, Jan. 3, 1903.)—The author gives a useful summary of the systems in use up to the end of the year 1902, accompanied by some critical remarks. G. W. DE T.

Digitized by Google

SCIENCE ABSTRACTS.

Section B.—ENGINEERING.

AUGUST 1903.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

601. *Triple-Expansion Engine.* (Engineering, 74. pp. 847–848, Dec. 26, 1902.)—This is a description, with dimensioned drawings, of a 300-kw. engine built for the Middlesborough Electricity Works by Davy Brothers, of Sheffield. The engines are of the vertical, triple-expansion type, and have cylinders 12½ in., 20 in., and 31 in. diameter by 30 in. stroke; speed 120 r.p.m., boiler pressure 160 lbs. per sq. in. Double-ported Corliss valves are used for all the cylinders, thus obtaining the short travel which is necessary in having a trip-gear running at this speed; the cut-off gear of all three cylinders is under the control of the governor. The engine shaft is connected to the dynamo shaft by a coupling, which will allow them to run a little out of line, this being preferred to having a single shaft made large enough to stand the severe straining actions set up if the bearings of the engine and dynamo are not perfectly in line. A test made after the engines had been working twelve months showed a consumption of 21·47 lbs. of steam per kw. hour; on this occasion the vacuum was only 22 in. instead of 24 in., and an allowance for this gives 19·55 lbs. per kw. hour as the equivalent consumption; the combined mechanical efficiency and dynamo efficiency was 89·75 per cent.

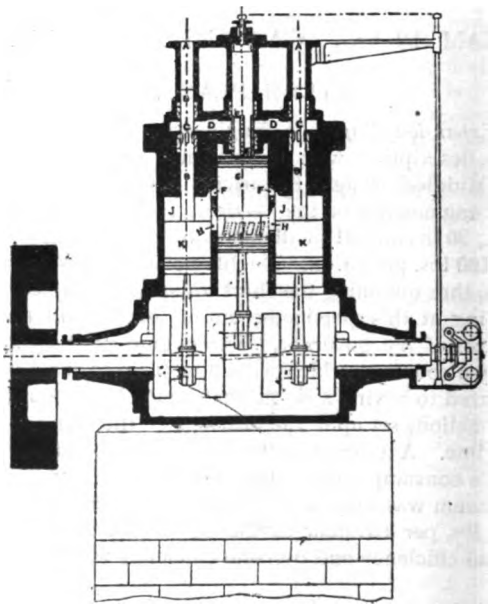
H. R. C.

602. *High-Speed Engine.* (Engineer, 95. pp. 124–125, Jan. 30, 1903.)—This is a description with drawings of a twin tandem compound single-acting high-speed engine of the completely enclosed type, designed by H. A. Hoy for the Lancashire and Yorkshire Railway Company, and which has become their standard unit for driving electric generators for power purposes. The high-pressure cylinders are 10 in. diameter, and the low-pressure 14 in. diameter by 6 in. stroke; the normal speed is 460 r.p.m., and with a boiler pressure of 160 lbs. per sq. in., the i.h.p. is 100. The steam distribution for each cylinder is effected by means of two piston valves working over ports in the cylinder head, separate valves being used for admission and exhaust; the usual bars across the ports are dispensed with by making the single split ring in the valve piston so long that at least half its length is always supported

Digitized by Google

by the plain part of the cylinder in which it slides. The eccentrics form part of the crank webs and the valve spindles pass through the pistons, the holes in which are fitted with gun-metal bushes; the valve rods are kept in thrust by having live steam admitted above the high-pressure valve. The connecting rod is maintained in thrust by having a non-return valve of very small lift which produces a vacuum below the low-pressure piston on the up-stroke. H. R. C.

603. *High-Speed Engine.* (Electrical Times, 23. pp. 251–252, Feb. 12, 1903.)—This engine is manufactured by Messrs. Goodfellow, of Hyde, and is remarkable in having the steam distribution effected entirely by the movement of the piston rods, so dispensing with valve gear and separate valves. There are two low-pressure cylinders JJ with cranks in line; the high-pressure cylinder, being between them and its crank, is about 180° in advance of the low-pressure cranks. Steam is admitted to the points AA, and passes through the hollow trunks BB, which are prolongations of the low-pressure piston rods; it is admitted to the space D through the ports CC, and hence



through the ports E to the high-pressure cylinder. Cut-off takes place by the closing of the ports E as the piston descends. When the top of the high-pressure piston G descends to the port F, the steam passes to the top of the low-pressure pistons KK, escaping through the lower part of the high-pressure cylinder to the exhaust pipe when the piston G uncovers the port H on its upward stroke. A shaft governor actuating a throttle-valve is used. A set of indicator diagrams is given, but no tests of the steam consumption appear to have been made, for no figures are given. H. R. C.

604. *Test of Engine with Superheated Steam.* **J. A. Ewing.** (Mech. Eng. 11. pp. 88–89, Jan. 17, 1903.)—This is a report of a series of tests made on a horizontal tandem two-cylinder compound engine, with a Schmidt reheater

Digitized by Google

in the receiver between the two cylinders. Steam was supplied from a Lancashire boiler at 140 lbs. per sq. in. pressure, and superheated in an independently fired Schmidt superheater to about 800° F. It reached the engine at about 750° F., but before admission gave up about 170° F. of this superheat to the steam in the receiver. Engine cylinders were 15 in. and 24 in. diameter, and the stroke 28 in. Speed was 140 r.p.m. There was a jet condenser. Trials under full load for 7 hours, under half-load for 3 hours, and under three-quarters of full load for 5 hours, were carried out, and were followed by a shorter run under no load, except a few lamps in the engine and boiler-house. The general results were as follows :—

Trial Number.	I.H.P.	Effective Electrical Output, KW.	E.H.P.	Ratio of E.H.P to I.H.P.	Number of lbs. of Steam.		
					Total per Hour.	Per I.H.P. Hour.	Per Electrical Unit.
I.	312	190	255	0·82	2,925	9·4	15·4
II.	239	148	192	0·80	2,150	9·0	15·0
III.	175	97	180	0·74	1,670	9·5	17·2
IV.	47	8·5	4·8	—	975	—	—

Particulars of the temperatures and pressures observed and diagrams of steam consumption are given. At an evaporation of 8·7 lbs. steam per lb. coal, and a consumption of 9 lbs. steam per i.h.p. hour, the consumption of coal would equal 1·41 lbs. per i.h.p. [See also Abstract No. 2303 (1902).]

F. J. R.

605. *Tests of a De Laval Steam Turbine.* (Power, N.Y. 22. pp. 20–21, Nov., 1902. Excerpts from a report by **Dean** and **Main.**)—An account of some tests at varying loads with saturated and with superheated steam, the power being altered by using different numbers of nozzles, varying from 8 to 3. The average consumption with 8 nozzles in use was 15·17 lbs. per b.h.p. hour with saturated steam, and 13·94 lbs. with 84° F. superheat, the b.h.p. being 333 and 352 respectively. H. R. C.

606. *Externally-fired Boilers.* **W. H. Fowler.** (Mech. Eng. 11. pp. 187–188, Feb. 7, and pp. 242–244, Feb. 21, 1903.)—The chief advantage ascribed to this class of boiler consists in its having the furnace independent of the boiler, so that it can be made greater in area and capacity than would be permissible with a similar sized boiler of the internally fired type. The design of these boilers as a rule involves simplicity of manufacture and low cost. Their form and dimensions, however, coupled with the necessary method of heat application and distribution, entail serious racking stresses, which interfere with the safety of the boiler and prevent its adaptation to high pressures or forced combustion. The author discusses the plain egg-ended, the small plain cylindrical, one form of the elephant, and the cylindrical multi-tubular boilers, with a form of externally fired Lancashire or Cornish boiler, and diagrammatic illustrations of these are given in the paper. Of these the author gives the preference to the form of elephant boiler shown, on account of its smaller diameters and the disposition of its heating surface. And with regard to externally fired Lancashire or Cornish boilers, he advo-

Digitized by Google

cates the construction of an external firing chamber which will allow the products of combustion to pass directly into the internal flue, rather than the method of firing them under the external shell. Feeding such boilers with cold water is strongly disapproved of. F. J. R.

607. *Efficiency of Boiler Furnaces.* **C. E. Stromeyer.** (Mech. Eng. 11. pp. 225–228, Feb. 14, 1908.)—Published results of boiler tests reveal enormous variations in the efficiency of boilers worked under practically identical conditions. Two instances of hand-fired Lancashire boilers, No. 7 and No. 57 in Donkin's "Heat Efficiency of Steam Boilers," both burning English coal, the former at the rate of 18·8 lbs., and the latter at the rate of 16·5 lbs. per sq. ft. of grate, and evaporating 8 lbs. and 5·6 lbs. of water respectively per sq. ft. of heating surface, show that the efficiency of the lightly worked boiler No. 7 is only 58·7 per cent., against 71·6 per cent. in the case of the hard-worked boiler No. 57. In the case of No. 12 and No. 67 the hard-worked boiler is the more inefficient, their performances being in the ratio of 58·2 and 74·8. It became evident to the author that those boilers were the least efficient in which the excess of air was largest in the conditions of firing, and this subject is carefully examined and reasoned out, the author showing that reduced flame temperature and larger volume of waste gases fully account for reduced duty. The author found that the transmission of heat was not proportional to the square of the difference of temperature between the hot gases and the water, but was apparently proportional (C_1) to the difference of temperature, or (C_2) to the two-thirds power of that difference. Adopting generally these two assumptions, Table I. gives the coefficients of heat transmission obtained for various types of boilers and other apparatus:—

TABLE I.

COEFFICIENTS OF HEAT TRANSMISSION.

B.Th.U. transmitted per hour per sq. ft. per 1° F. difference on either side of plate.

Type of Boiler or Condition.	C_1.	C_2.
Water on both sides (condensers)	500 to 600	—
Marine boilers	5·55	0·322
Locomotive portable boilers	5·21	0·251
Lancashire and Cornish boilers	5·05	0·251
Water-tube (Belleville with economisers) ...	5·26	0·225
Economisers	2·79	0·141

In the first case, $\log. T_0 - \log. T = C_1 . 1·84$ HS/Q, and in the second case, $1/\sqrt{T} - 1/\sqrt{T_0} = C_2 . 1·191$ HS/Q, where T_0 = the initial temperature of the flame in excess of the steam temperature, T = excess temperature of waste gases after they have traversed HS sq. ft. of surface. T_s = excess of steam temperature over atmosphere. The efficiency is $(T_0 - T)/(T_0 + T_s)$. The losses due to radiation must be deducted from this. Q, the total weight of the waste gases, is derived from the weight of fuel and the analysis of the waste gases, and being compared with HS, the heating surface, gives T, the final temperature. The relative weight of fuel q, to waste gases Q, indicates the temperatures T_0 and T_s. Approximately, $T_0 + T_s = 60{,}000\ q/Q$. Heat transmission and boiler efficiency are not synonymous, the controlling factors being the amount of excess air admitted to furnaces and the radiating surface

Digitized by Google

of the boiler. Table II. is based on the logarithmic formula given above. Perfect combustion is attained when Q/q = about 12½. Column I. represents absolutely incomplete combustion; Column II. a ratio of 16 to 1, which is possible with the best conditions of combustion; Column III. is fairly good practice; Column V. is sometimes reached when much air is admitted to reduce smoke nuisance; and Column VI. is downright bad practice. In the third division from the top the excess temperatures are those over 60° F.

TABLE II.

	I.	II.	III.	IV.	V.	VI.
Ratio of waste gases and fuel Q/q.....	6·8	16	21	26	31	41
Estimated flame temperature, $T_0 + T_s$ °F.	2,350	4,130	2,920	2,350	1,970	1,490
Estimated excess temperature T_0...°F.	2,050	3,830	2,620	2,050	1,670	1,190
T_s being assumed to be 300° F.....						
Estimated final excess temperatures, T.						
Square feet of heating surface per lb. of fuel burnt per hour ..... $\frac{HS}{q} = \frac{1}{4}$	942	2,750	2,041	1,671	1,411	1,050
" ½	431	1,981	1,581	1,361	1,191	920
" 1	98	1,019	955	908	843	711
" 2	4	271	348	402	426	424
" 4	0	16	46	79	108	151
Estimated final temperature, $T + T_s = T + 300$.						
Square feet of heating surface per lb. of fuel burnt per hour ..... $\frac{HS}{q} = \frac{1}{4}$	1,242	3,050	2,341	1,971	1,711	1,350
" ½	731	2,281	1,881	1,661	1,491	1,220
" 1	398	1,319	1,255	1,208	1,143	1,011
" 2	304	571	648	702	726	724
" 4	300	316	346	739	408	451
Estimated percentage of heat wasted up chimney, $\frac{T + 300}{T_0 + 300}$ 100.						
Square feet of heating surface per lb. of fuel burnt per hour ..... $\frac{HS}{q} = \frac{1}{4}$	85·9	73.8	80·2	83·8	86·8	90·5
" ½	79·4	55·2	64·4	70·6	75 6	81·8
" 1	75·2	31·9	43·0	51·4	53·0	67·8
" 2	74·1	13·8	22·0	29·9	36·8	48·6
" 4	74·0	7·7	10·8	16·1	20·7	30·2
Efficiency of Heating Surface.						
Estimated percentage of heat passing into the water, $100\left(1 - \frac{T + 300}{T_0 + 300}\right)$						
Square feet of heating surface per lb. of fuel burnt per hour ..... $\frac{HS}{q} = \frac{1}{4}$	14·1	26·2	19·8	16·2	13·2	9·5
" ½	20·6	44·8	35·6	29·4	24·4	18·2
" 1	24·8	68·1	57·0	48·6	47·0	32·2
" 2	25·9	86·2	77·8	70·1	63·2	51·4
" 4	26·0	92·3	89·2	83·9	79·3	69·8

$HS/q = \frac{1}{4}$ may be taken as the temperature of waste gases entering the smoke tubes in a not over-worked marine boiler; $HS/q = 1$ represents the temperature of waste gases leaving the flue of Lancashire boilers; $HS/q = 2$ those

Digitized by Google

from a boiler with heating surface thirty times grate surface and burning 15 lbs. of fuel per sq. ft. per hour ; $HS/q = 4$ represents a very lightly-worked boiler. The author advocates double combustion, *i.e.*, the fuel to be burned on the grate with a minimum supply of air so that some carbon monoxide will be formed, and the gases to be re-ignited with a subsidiary supply of air after passing over some of the heating surface. This will prevent the furnace plates being exposed to excessive temperature, and will give a better result than excessive air supply to the furnace. F. J. R.

608. *Circulation in Shell Boilers.* **W. Thomson.** (Inst. Engin. and Shipbuilders, Trans. 46. Part 3. pp. 16–34, Jan. ; Discussion, Part 6. pp. 1–31, March, 1903.)—The author enunciates some of the elementary principles of combustion of coal, circulation of the hot gases, transference of heat to the interior of boilers, and circulation of the water therein, and then discusses the effect of the addition of Makin's fire cones to boilers of the Lancashire and Cornish types. He also advocates the use of methods of analysing the waste gases by means of apparatus like that of Orsat, Arndt, or others. *In the discussion* **S. Couper** stated that the problems associated with the movements of water, air, flue gases, and heat were the same for all types of boilers. He referred to the results published by W. G. Spence ("On the Combustion of Coal," Trans. N.E. Coast Inst. of Engineers and Shipbuilders, 1888) to show what could be done with hand firing, and showed Hill's pyrometers, made by Baird and Tatlock, as being reliable instruments for ascertaining flue temperatures. He did not consider the results of trials with Makin's cones conclusive. **F. J. Rowan** quoted Bryant's experiments on heat transmission (Min. Proc. Inst. C.E. cxxxii. 274) to show that convection was more efficacious than radiation, and maintained that the radiant heat should be employed to increase the temperature of combustion. **C. A. Matthey** showed that the comparison used for determining the economy of Makin's tubes was illusive. F. J. R.

609. *Flame Analysis and Fuel Combustion.* **W. H. Booth.** (Elect. Rev. 52. pp. 23–25, Jan. 2, 1903.)—Based upon the fact that the invisible ultra-red and ultra-violet rays of the spectrum are the most energetic in producing heat and chemical effects, the author proposes that combustion temperatures in furnaces should be examined by means of a violet-coloured glass or analyser. Temperature being closely connected with actinism, the analytical investigation of the light of a furnace will give a fair insight into its conditions of temperature. The effect of the use of violet-coloured glass will be that all the less active rays than the violet will be eliminated, the interior of brilliant furnaces being rendered quite visible and of the tint which marks the ultra-violet end of the spectrum. The more perfect the combustion the larger will be the proportion of violet light emitted by the flame, and although combustion may take place at temperatures below those which produce that effect, the violet degree of actinism must be fully developed if combustion is to be perfect. Applied to the examination of different kinds of furnaces this method proves the hopelessness of those in which the gases come in contact with water surfaces—as in most water-tube boilers—before the gases rising from the fire have been thoroughly mixed and burned in a free space. F. J. R.

610. *The Fuel-value of Refuse.* **W. H. Booth.** (Elect. Rev. 52. pp. 245–246, Feb. 6, 1903.)—A short article on the commercial aspects of refuse-

Digitized by Google

destructors. All refuse has a value as fuel, and contains sufficient heating power to complete its own destruction when burned under proper conditions. No progress was made, however, until it was seen that brick-lined non-conducting combustion chambers were essential, and the attempts to burn refuse in ordinary boiler furnaces were doomed to failure. The fuel-value of average town refuse is about one-sixth that of coal.

A steady day load is required for a destructor-plant used for generating electricity, and in the absence of this no thermal storage plant, as at Shoreditch, can make the works a commercial success. In such a district as Shoreditch a steady day load can only be obtained by encouraging the use of electric power by a host of small consumers, and the maximum demand system is wholly unsuited for developing such a demand for current. A flat rate for power consumption is required to meet the necessities of this station, and of others similarly situated. Until steady day-loads have been secured, there will be little prospect of destructor plants making a profit as generating stations. In any power station it will be found that a steady load-curve and a high factor accompany a multitude of users. J. B. C. K.

611. *Solid Rings on a Solid Piston.* (Engineer, 95. p. 122, Jan. 30, 1903.)—Solid rings on solid pistons having been used lately by Yarrow, a set of photographs, supplied by him, are here given to illustrate the method by which uncut rings are sprung over the end of the piston-block. It is stated that with superheated steam it is necessary to have the rings floating, and that in order to prevent any steam pressure behind the ring causing it to press unduly on the cylinder the rings must be uncut; it is of course a considerable advantage to avoid having a junk-ring. A clearance of 0″·003 to 0″·005 between the outside of the ring and the cylinder is sufficient; the floating ring will accommodate itself to a slight want of roundness at any part of the cylinder. H. R. C.

612. *Estimation of High Pressures.* (Engineering, 75. p. 81, Jan. 9, 1903.)—For a dead-weight gauge tester suitable for pressures up to 10 tons per sq. in. the weights would have to be inconveniently large if the plunger were of moderate size; in arranging such a gauge tester at the National Physical Laboratory the method adopted has been to have the fluid under pressure acting upwards on one piston, and downwards on a second piston, which is slightly smaller in diameter, the pistons being connected externally and the platform for the weights placed above; the effective area of the plunger is thus the difference of the areas of the pistons. In the instrument used this is 0·01804 sq. in., so that a load of 29·21 lbs. corresponds to a pressure of 1 ton per sq. in. The objection to the arrangement is that while the effective area is the difference of the areas of the plungers, the friction is the full friction of both; this difficulty has been overcome by using a suitable lubricant as the fluid under pressure, by limiting the motion of the plunger to a range of about 0″·02, and by giving the weights and plungers a slight oscillatory motion as is generally done with single plunger dead-weight gauge testers. H. R. C.

613. *High Pressure Steam Piping.* **W. Andrews.** (Amer. Electn. 15. pp. 17–18, Jan., 1903. Abstract of paper read before the Engine Builders' Association, Dec. 2, 1902.)—The author considers that the trend of modern practice during the last few years is to use steam mains of a smaller size than was formerly considered necessary. He points out that in four power stations in New York, the capacity of each being 60,000 to 100,000 h.p., the largest

Digitized by Google

steam mains are not more than 20" diameter. These pipes are carried into a receiver having three times the volume of the high-pressure cylinder; the receiver being placed as close as possible to the engine and the pipe from it to the valve chest being of ample size; this arrangement gives a full supply of steam close to the valve, and a steady and rapid flow of steam in the pipe, protected by the capacity of the reservoir from the sudden stoppage at each cut-off. H. R. C.

614. *The Harris-Anderson Oil Separator.* (Génie Civil, 42. pp. 184–186, Jan. 17, 1903.)—The author demonstrates by microscopic slide diagrams that water from the condensers of steam engines contains particles of oil in an exceedingly fine state of division. These minute globules have a diameter of from 1-2000th to 1-4000th of a millimetre, and they show no tendency to coalesce even after nine years, although in course of time they form groups of distinct particles. Under the microscope they are observed to possess the power of rapid movement. To the eye, the water containing them appears milky, and the oil is thus in the state of an emulsion which cannot be dealt with by ordinary filtering methods. The Harris-Anderson method consists in forming a precipitate with alumina sulphate and sodium carbonate, small quantities of which in solution are mixed with the water after its escape from the condenser and before it is passed through the filter. The precipitate causes an artificial aggregation of the particles, by enveloping them, in the well-known manner, by means of which they can then be arrested by the porous material of the filter. Illustrations are given of the apparatus employed in this process, which comprises a distributer, a dissolver, and a filter. The distributer automatically separates 2 per cent. of the water from the condenser discharge, and diverts this quantity to the dissolver, from which it takes up the proper quantity of the saturated solution of the salts and conveys it to the rest of the water, the whole amount being then passed through a filter of either a sacque or a disc form. [See also Abstract No. 1946 (1902).] F. J. R.

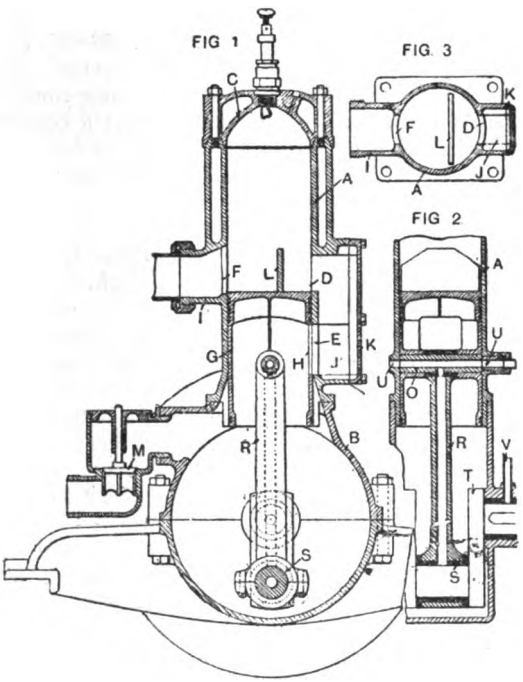
615. *Vacuum Intensifier.* (Mech. Eng. 11. p. 152, Jan. 31, 1903.)—Illustrations and description are given of an apparatus, designed by C. A. Parsons, for increasing the vacuum in condensers. The device is a combination of air-pump with a propelling jet operated by steam, whereby the gases and vapours proceeding to the air-pump are assisted in their progress, thus, of course, aiding the vacuum production. A diagram of the arrangement shows the condenser placed above the air-pump so that the water of condensation flows to it by gravity, whilst the air and water vapour are sucked from another part of the condenser by the steam-jet ejector or vacuum intensifier. This intensifier has been found to work best with a nearly vertical position of the jet and discharge neck, so as to prevent accumulation of water in the suction-box. In some cases the best result has been obtained by mingling the discharge of air and water vapour from the intensifier with the water of condensation on its passage to the air-pump, and using a small auxiliary condenser to condense the vapour and cool the water before they enter the air-pump. F. J. R.

GAS AND OIL ENGINES.

616. *Double-acting Internal Combustion Engine.* (Mech. Eng. 11. p. 288, Feb. 28, 1903.)—The arrangement of this engine, invented by G. E. Lemaitre,

Digitized by Google

is shown in the accompanying diagram. The charge is drawn in through the valve M on the up-stroke of the piston ; when the piston descends M is closed and the charge compressed in the casing until the orifice H in the piston uncovers the part E, which takes place before D is uncovered ; the charge passes into the cylinder when D is uncovered, and is deflected to the top of the cylinder by the plate L. On ascending, the piston first closes the openings D and F, and then compresses the charge in the cylinder, at the



same time drawing in a fresh charge through M. The inside of the cylinder cover C is parabolic, and the ignition is by means of an electric spark which takes place between terminals set at about the focus of the parabola. At the end of the down-stroke, the exhaust port F is opened before D, the exhaust gases expand and partly escape, the remainder being displaced by the fresh charge which enters at D, and is deflected by L so as to keep behind the spent gases. H. R. C.

617. *Brooke Engine and Carburetter.* (Automotor Journ. 8. pp. 200–201, Feb. 21, 1903.)—This petrol engine has three vertical cylinders with bodies and heads in one casting and mounted on an aluminium crank chamber. The valves are all on one side and mechanically operated. The carburetter is of the float-feed spray type, with an ingenious arrangement of throttle governor operated by the suction of the engine, the throttle piston closing when the speed of the engine exceeds a certain value unless prevented from doing so by means of an accelerator. C. R. D'E.

Digitized by Google

AUTOMOBILISM.[1]

618. *Locomobile Steam Cars.* (Automotor Journ. 8. pp. 217–223, Feb. 28, 1903.)—The latest types of these cars are described with numerous illustrations. Amongst the most noteworthy improvements over the earlier types are the enclosing of the engine so that all working parts are protected from dust, and the adoption of wheel steering. The cars are greatly improved both in details and in general soundness of construction. C. R. D'E.

619. *Earl Petrol Cars.* (Automotor Journ. 8. pp. 193–195, Feb. 21, 1903.)—These cars are fitted with double-cylinder vertical petrol engines of 9 h.p., mounted towards the front of a rectangular underframe constructed of wood and steel plates. The transmission gearing includes a cone friction clutch, a change-speed gear giving three speeds forward and one reverse by means of sliding spur gears, a bevel transmission to the differential cross-shaft, and chain gears to the rear road-wheels. C. R. D'E.

620. *Chenard and Walcker Petrol Car.* (Automotor Journ. 8. pp. 105–107, Jan. 31, and pp. 154–157, Feb. 7, 1903.)—This is a light car fitted with a two-cylinder 10-h.p. engine mounted towards the front of a wood and steel-plate frame. The transmission is by cone-clutch and spur-wheel and bevel change-gear to the differential cross-shaft, and finally by independent chains to the rear road-wheels. In the engine the two vertical cylinders are cast together and mounted on an aluminium crank chamber. Both inlet and exhaust valves are mechanically operated. The engine is governed by varying the lift of the inlet valves, and is remarkable for smooth and economical running. The article is well illustrated. [See also Abstract No. 2305 (1902).]
C. R. D'E.

621. *Thornycroft Petrol Cars.* (Automotor Journ. 8. pp. 169–172, Feb. 14, 1903.)—These cars are fitted with two- or four-cylinder vertical engines, according to power, viz., 10 h.p. and 20 h.p., the cylinder dimensions being 4 in. bore × 4⅜ in. stroke in each case. The engine is mounted towards the front of a channel steel frame and enclosed by a bonnet. The power is transmitted by a cone friction clutch to a three-forward and one-reverse speed-change gear, and finally by a jointed tail shaft to a bevel gear on the live rear axle. C. R. D'E.

622. *Germain Electric Change-Speed Gear.* (Automotor Journ. 8. pp. 196–198, Feb. 21, 1903.)—In this change-speed gear as applied to a motor vehicle the ordinary spur-wheel gear and cone friction are replaced by two series-wound electric generators with armatures mounted on a common spindle geared to the differential cross-shaft of the car by bevel wheel and pinion, and with field magnets in the one case rotated as a flywheel by a petrol engine, and in the other case fixed to the car frame. The machine with rotating field acts partly as a generator of electricity and partly as an electromagnetic clutch driving direct through the bevel gearing. The current generated is employed to drive the other machine as a motor. The final transmission to the road-wheels of the car is by chain gearing. C. R. D'E.

---

[1] Electric Automobiles are described in the Section dealing with Electric Traction.

Digitized by Google

INDUSTRIAL ELECTRO-CHEMISTRY AND GENERAL ELECTRICAL ENGINEERING.

623. *Electrolytic Refining of Gold.* **D. K. Tuttle.** (Electrochem. Ind., Philadelphia, 1. pp. 157–158, Jan., 1903.)—An account is given of the application of Wohlwill's process for refining gold at the Philadelphia mint. A current of 600 amperes at 6 volts from a 5-h.p. dynamo serves seven porcelain electrolytic cells in series, each measuring 15 × 11 × 8 in., with twelve anodes and thirteen kathodes arranged in multiple. The anodes measure 6 × 8 × ½ in., and are 1½ in. distant from the kathodes. The bath contains 30 grms. of gold as chloride per litre, and sufficient hydrochloric acid to enable the anodes to dissolve freely without evolution of chlorine. It is used at a temperature of 50°–55° C., maintained by placing the baths on sand containing embedded steam-pipes. The solution is circulated by mechanical means. Platinum present in the anodes dissolves, but is not deposited at the kathode. It is recovered by chemical methods. If more than 5 per cent. of silver be present, the anodes require cleansing mechanically. At present 5,000 oz. of gold are refined per week with an expenditure of 1 h.p., and the cost of the hydrochloric acid used is 20 cents per 1,000 oz. of gold deposited. One attendant regularly, with occasional assistance from a second, suffices for the work.

W. G. M.

624. *The Keller Electric Furnace and Process for Steel Production.* (Electrochem. Ind., Philadelphia, 1. pp. 162–165, Jan., 1903. Abstract of a paper on this process, read by **C. Bertolus** at the Congress on Water-power, held in France in September, 1902.)—The process is in actual operation at the works of Keller, Leleux & Cie., Kerrousse, near Morbihan. The fall of the River Blavet, utilised for this plant, yields 550 h.p., and this is employed to drive four 185-h.p. turbines. One 375-h.p. furnace for steel production and four furnaces for producing steel alloys have been erected, and the trials made with these have shown that 2,800 kw.-hours are required to produce 1 ton of steel from the ore. The costs of production are based by Bertolus on the following costs and prices: Ore (55 per cent. Fe) delivered at the works, $2 per ton; coke, $8 per ton; fluxing materials, $3 per ton; wages average $0·60 per day; electrodes cost $6 per ton; and electrical energy, $10 per kw.-year of 8,400 hours. Using these figures as basis of his calculation, Bertolus estimated that the cost of 1 ton of steel by the Keller furnace and process would be about $18 to $20. The steel made by this process is satisfactory in quality, and can enter into competition in this respect with steels made by the Bessemer and Martin processes. A larger furnace is being erected at Kerrousse.

J. B. C. K.

625. *Electric Smelting of Iron Ores.* (Eng. News, 49. pp. 35–36, Jan. 8, 1903.)—The article is a criticism of Rossi's views regarding electric processes for smelting iron ores (Iron Age, Nov. 20, 1902). Rossi had stated that in an actual run of ten weeks' duration, the average yield showed 200 e.h.p. days of 24 hours (equal to 4,800 e.h.p. hours) had produced 1 ton of metal. Basing his calculation on this result, Rossi had calculated that 1 ton of pig-iron could be produced by the electric process for $12·15, as compared

Digitized by Google

with $12·47 by the ordinary blast-furnace procedure. The anonymous critic of these estimates points out that Rossi has assumed a much higher cost for iron ore for the blast furnace—$4·50 per ton, as compared with $0·75 for the electric furnace—and that he has also taken electric energy at the low cost of $10 per e.h.p. year. The most serious error in his estimates is, however, held to be his neglect to allow for the much higher capital expenditure per ton of iron produced, for the electric-furnace plant. According to the critic of Rossi's estimates, the erection of a blast-furnace plant for producing 350 tons of iron per day costs about $1,000,000. An electric installation for producing a similar amount of iron would require 60,000 h.p., and the cost of this water-power development *alone* would exceed the total cost of the blast-furnace plant, $5,000,000 being named as the lowest probable cost.

Finally, Rossi's figure for the cost of pig-iron by the blast-furnace procedure is much too high; in place of $12·47 per ton, it can be produced for $7 to $8. J. B. C. K.

626. *Tommasi Accumulator.* **Tommasi.** (Elettricità, Milan, 22. p. 52, Jan. 25, 1903.)—This is an accumulator in which the spongy lead is separately prepared in an electrolytic bath of double acetate of lead and soda with a kathode consisting of a rotating disc, half immersed in the solution. A. E. L.

627. *Variable Speed Control.* (Amer. Inst. Elect. Engin., Trans. 19. pp. 1592–1604, Dec., 1902.)—This is the discussion of a series of papers. [See also Abstracts Nos. 472, 480, 507 (1903).] **G. S. Dunn** said that some of the authors had described systems in which a motor is expected to give a constant output over speeds varied from 2 to 1 by means of weakening the field. Such a motor was very unusual and very expensive. **S. T. Dodd** said that the application of Ward Leonard's system to heavy locomotives (for which alone it seemed likely to be useful) might increase their weight by 50 per cent. **A. Williams** considered that the equipment of factories with individual motors was the right thing; it seems more expensive, but something is saved on the cost of shafting and belts. The work is capable of being turned out at much greater speed, and there is great economy of power. **N. W. Storer** and **H. Ward Leonard** considered that an ordinary well-designed motor ought to run with its field strength reduced to one-half of the normal amount. The latter admitted that his system would increase the weight of the locomotive; but he thought this might be an advantage, as it increased the weight on the driving wheels, and so increased the amount of power which could be developed without skidding the wheels. In any case it would only increase the weight of the train by 2 per cent. W. H. S.

628. *Variable Speed Control.* (Amer. Inst. Elect. Engin., Trans. 20. pp. 92–103, Jan., 1903.) (Discussion.)—This is a continuation of the discussion dealt with in the preceding abstract. **O. E. Osthoff** objected to Coho's suggestions as impracticable. He preferred an arrangement of 92 cells in four groups. On the first notch all the groups would be in parallel; on the second, two in series and two in parallel; on the third, all would be in series; on the fourth, the motor would be thrown on the mains, and the battery charged at a slow rate separately. **B. J. Arnold** pointed out that Lozier's paper neglected the consideration of the prime cost of the individual motor system, which was in the case of small tools almost

Digitized by Google

prohibitive, besides being frequently uneconomical; in such cases, they ought to be grouped together, and driven off a short length of shafting by one motor. **E. Gonzenbach** mentioned the case of a railway repair shop, which was driven by two 5-h.p. motors; individual motors would have amounted to 85 h.p. He also objected to rotary substations. The wages paid to men who were capable of running such substations were very high, and such men had in reality more difficult work than those at the power-house, and had to rely entirely on their own wits in an emergency. Moreover these substations had to be large; otherwise they were liable to cramp the general traffic arrangements. On the Aurora Railway, there is a total capacity of 2,500 kw. in rotary converters to be operated from a generator of 1,500 kw. capacity, because it is possible that at times the trains are more numerous on one part of the line than on another. **Cutler** referred to Keilholtz's paper [see Abstract No. 479 (1903)]. He considered the Ward-Leonard system unsuitable for coal hoists. It is very slow to act, as the field strength of a generator cannot be altered in a few seconds; and further, a shunt-wound motor does not pick up the load as quickly as a series-wound motor. He preferred a series motor with ordinary armature resistance, controlled by magnets which eliminate sparking. The magnets are energised through a lever, retarded by a dashpot, thereby obtaining with proper adjustment the maximum acceleration. He also objected to the variable-voltage system, and preferred to use sliding gears, as in an automobile. For printing presses, he would use the double-motor system, and said that in practical work there was no necessity for an unlimited number of steps from minimum to maximum speed. Storage batteries were not suitable for this work. Generally he did not approve of varying the speed of a motor beyond that produced by weakening the shunt by 20 per cent. W. H. S.

629. *Electric Capstans at the Port of Antwerp.* **L. Brunhes.** (Assoc. Ing. Él. Liége, Bull. 2. pp. 634–654, Nov. and Dec., 1902.)—In this case, hydraulic capstans have been replaced by electric capstans of a number of different types, all running off the street mains of the city, which supply continuous current on the three-wire system with 220 volts between the outers. The following are described. (1) A Schuckert capstan having a 15-h.p. compound-wound motor mounted with its armature-shaft vertical and bearing a pinion which engages with an internal gear-wheel on the shaft of the capstan-drum or head. The switch of the starting rheostat is actuated by a counter-weighted pedal. (2) The Figee capstan, in which the armature-shaft of the series-wound motor is arranged co-axially with the capstan-head, which it drives through sun and planet gearing. (3) The Beer capstan, which is illustrated, is similar to the Schuckert above mentioned and has a 4-pole compound-wound motor. The controller and starting-rheostat are controlled by two pedals, one of which, through ratchet gear, advances the rheostat-lever one tooth of the ratchet-wheel for each depression, whilst the other raises the pawl of the ratchet-gear and allows a spring to bring the rheostat-lever into the open-circuit position. (4) The Beer worm-gear capstan. In this arrangement, which is illustrated, the worm-shaft is provided with ball thrust-bearings. This capstan has been at work day and night for two years without showing any appreciable wear. (5) The direct-driven Beer capstan (illustrated). This has an 8-pole compound-wound motor, and has an electric brake which will stop the motor in a quarter revolution. The starting switch is actuated by means of an electromagnet, the circuit of which is controlled by a pedal-switch, the motion of the starting switch-lever being controlled by

Digitized by Google

a dashpot. (6) The Siemen's geared capstan (illustrated). In this capstan, a series-wound motor having a horizontal shaft is employed, which is connected to the capstan-head by spur and bevel gearing. The pedal here also controls the circuit of an electromagnet actuating the starting-switch, which is also controlled by a centrifugal governor driven from the armature-shaft of the motor, so as to cut out all resistance when a certain speed is attained. (7) Figee Capstan (Type II.). Vertical armature-shaft; spur gearing. (8) La Cie. Internationale d'Électricité capstan; worm-gear. (9) Siemen's worm-gear capstan. Provided with the Pekrum worm-gear, in which the teeth of the worm-wheel are formed by conical steel anti-friction rollers, and which has an efficiency of 91 per cent. The average cost of running for all the different capstans, which each make from 8,000 to 25,000 revolutions per day, is about 19d. per capstan per day, the current costing 2·85d. per kw.-hour. The hydraulic capstans displaced cost 16s. each per day. The maintenance of the electric capstans averages £11 7s. 6d. each per annum, against £89 11s. 8d. for the hydraulic capstans. The torque obtained is greater with the electric capstans. A special device is also described and illustrated for moving locomotive turntables. This comprises a 10-h.p. Beer series motor, driving through double reduction gear a wheel running on the circular rail on which the turntable runs. This motor is controlled by a three-point electromagnetically-actuated switch (diagram given), whereby "forward motion," "backward motion with brake," and "brake alone" can be obtained. C. K. F.

REFERENCES.

630. *The Present Metallurgy of Aluminium.* **J. W. Richards.** (Electrochem. Ind., Philadelphia, 1. pp. 158–162, Jan., 1903.)—This is an historical account of the introduction of Héroult's and Hall's processes, incidentally defending their claims to priority as against that of Minet, and insisting that the commercial production of aluminium in America is due to the Hall processes. A review is given of some recent measurements and statements relating to aluminium extraction. W. G. M.

631. *Application of Aluminium to the Preparation of Pure Metals.* **C. Pio.** (Rivista Sci.-Industriale, 34. pp. 155–157, Nov. 15, 1902. From the Monitore Tecnico.)—A general account of the use of aluminium in metallurgy, and statistics of the world's production of aluminium from 1885 to 1898. D. H. J.

632. *Aron Energy Meter.* **M. Aliamet.** (Électricien, 25. pp. 17–21, Jan. 10, 1903.)—This is a description of the latest form of Aron meter for high-tension alternating current. A special form of transformer is used with the instrument. [See also Abstract No. 585 (1903).] E. S. A. R.

Digitized by Google

GENERATORS, MOTORS, AND TRANSFORMERS.

633. *Contact Resistance of Carbon Brushes.* **Bourguignon.** (Soc. Int. Élect., Bull. 8. pp. 26–48; Discussion, pp. 48–48, Jan., 1903.)—The author measured the contact resistance by measuring the difference of potential between two carbon brushes pressing on the same commutator plate with a known current passed from one brush to the other through the commutator. The commutator used was 126 mm. diameter, 65 mm. long, with 44 plates 8 mm. wide. Before beginning the experiments the commutator was run for several hours at a linear velocity of 8 m. per sec. with a pressure of about 600 gr. per sq. cm., first with no current, then with 10 amperes per sq. cm. The brushes used were 16·5 × 9·5 mm. Starting cold, he found the difference of potential fell from 1·44 to 1·18 in 30 minutes, and then remained about constant. In the following experiments the machine was run for 30 minutes with 20 amperes with a pressure of 650 gr. per sq. cm., at a linear velocity of 5·4 m. per sec. The brush pressure was measured by raising the brush by a weight, with a small current passing, the voltmeter showing when contact was broken. The author gives a number of curves showing the effect of varying the current density, linear velocity and pressure on the brushes. With a low-current density the resistance falls rapidly as the current density increases, in one case from nearly 1 ohm per sq. cm. to 0·1 ohm, with current density rising from 0 to 10 amperes per sq. cm. The resistance rises as the velocity increases, and falls as the pressure increases, the variation being greatest at a low-current density, but at 20 amperes per sq. cm. the resistance is about 0·1 ohm per sq. cm. at 5·4 to 13·33 m. per sec. with a pressure of 630 gr. per sq. cm., and at 3·35 to 6·7 m. per sec. with 255 gr. per sq. cm. Above a certain velocity, which is greater as the pressure and current density are greater, the resistance increases rapidly, and sparks appear. This seems to be due to vibration. The friction loss varies from 26 watts per sq. cm. at 720 rèvs. to 66 watts at 1,500, with a pressure of 1,280 gr. per sq. cm., and from 6·5 watts at 530 to 35 watts at 1,450, with 640 gr. per sq. cm. The total power loss in the brushes $P = (r\delta + 4{\cdot}9\,pv/\delta)I$, where r = resistance, p = pressure in kg. per sq. cm., v = velocity in m. per sec., δ = current density. For any particular velocity and brush pressure there will be a certain current density which will give a minimum loss; if the actual current density is lower than this it will be possible to reduce the loss by raising some of the brushes. The author gives tables of results of experiments with four different samples of carbon: a specimen with a very fine grain, taking a high polish, copper-plated the whole length, gave the lowest resistance. *Discussion*: **Hospitalier** said that the usual brush pressure for fixed machines was 150 gr. per sq. cm. **Bourguignon** said that the pressures used in his experiments were actually used in practice. **Gratzmuller** thought there were always arcs under the brushes, and that if experiments were made with two carbons, one three times the section of the other, the contact resistance would be found to be the same. **Bourguignon** thought that M. Gratzmuller was mixing two phenomena, commutation and contact resistance, which he (Bourguignon) had tried to separate. **Brunswick** thought experiments should be made on rings instead of commutators. **The President** did not agree with this; he

Digitized by Google

thought the insulation in the commutator modified the state of the surface. **Girault** thought that the interference of commutation and self-induction of the armature, might be got rid of by short-circuiting all the commutator plates.

R. B. R.

634. *Armature Reaction of Alternators.* **C. F. Guilbert.** (Elect. World and Engineer, 40. p. 658, Oct. 25; pp. 788–789, Nov. 8; p. 816, Nov. 22; pp. 867–868, Nov. 29; p. 899, Dec. 6; p. 944, Dec. 13; pp. 1,003–1,004, Dec. 20; pp. 1,041–1,042, Dec. 27, 1902; 41. pp. 32–33, Jan. 3; and pp. 116–118, Jan. 17, 1903.)—A brief *résumé* of the various methods used by engineers to determine the load characteristics of single-phase and polyphase alternators is given, and their limitations are pointed out. Several new formulæ and methods are given by the author, and they are applied to various machines, the data of which have been published previously. The results show that to a first approximation we can determine the load characteristics by calculation. Following Blondel the author splits the armature current i into two components, $i \sin \phi$ and $i \cos \phi$ respectively, where ϕ is the phase difference between the current and the no-load voltage. The component $i \sin \phi$ produces a direct demagnetising effect on the field magnets, and $i \cos \phi$ produces a transverse magnetisation of the field in the same way as the armature current in a direct-current machine. A complete proof of the following formula is given for the demagnetising ampere turns of the armature (F_i)—

$$F_i = \frac{4a}{\pi^2 b} \sin \frac{\pi b}{2a} \sin \frac{\pi b'}{2a} NI \sin \phi$$

where a = the polar step, b = the breadth of the polar flux entering the armature, b' = the distance between the axes of the slots containing the armature coil, N = the number of turns per armature pole, and I is the maximum value of the current. The above formula applies to single-phase machines. For polyphase machines we have to multiply it by the number of phases (m) and 2N is now the number of conductors per pole and per phase. Several numerical examples are given showing how to apply the formula to various kinds of windings. If F′ be the compensating ampere turns required for the field, then—

$$F' = F_i \left(1 + \frac{r}{R_a}\right)$$

where r = the reluctance of the field poles and frame, and R_a = the reluctance of the field leakage circuit. In most machines $\frac{r}{R_a}$ is less than 0·1; 0·08 is the value the author takes in working out examples. In proving the formula for F_i the current in the armature is supposed to follow the harmonic law, and in proving the formula for F'_i, r is supposed to be constant. Owing to the increased flux r increases, and the author gives an amplified formula and shows how Δr can be found from the curve of no-load field flux. With the same assumption as to the current law the transverse magnetising turns F'_i in polyphase machines, can be calculated from—

$$F'_i = m \frac{4a}{\pi^2 b} \left(1 - \cos \frac{b\pi}{2a}\right) \sin \frac{b'\pi}{2a} NI \cos \phi.$$

It will be noted that F_i is equal to F'_i when b is equal to a. Methods of determining F_i and F'_i experimentally are given. The diagrams for determining load characteristics are divided into three classes. First, those which

Digitized by Google

only involve the flux or the e.m.f. produced. The earliest of this class is the Kapp, and the best known are the Behn-Eschenburg, Blondel, E. Arnold and Picou. These methods when they take into account the transverse and direct reactions are fairly accurate. The Blondel method as modified by Picou appears to the author to be the most accurate, although the assumption of a linear distribution for the transverse m.m.f., which is true for direct-current machines, is not justified for alternators. [Owing to the omission of a diagram (Fig. 8) it is not easy to follow Guilbert's method.] The second class involves only the ampere turns, and practically the only method is that of E. Arnold, which can easily be modified to take into account the increase of field magnetic leakage with load. The third class, which takes into account the e.m.f.'s and flux as well as the ampere turns, is much the most numerous. The diagrams of Rothert, Heyland, Potier, Niethammer, Bauch and Guilbert are mentioned. These are generally modifications of asynchronous motor diagrams similar to those published by Blondel in 1896, and it is doubtful whether they can be applied to alternators with separate poles.

A. R.

635. *Heating of Traction Motors.* **E. Kerbaker.** (Elettricista, Rome, 12. pp. 16–20, Jan., 1903.)—By taking the time required to raise the temperature of the motor by a given amount, and plotting the values for different currents, the author shows how, for a given profile of line, a curve may be drawn showing the rise and fall of temperature for a given size of motor, of which the speed and torque curves are known, thus ascertaining whether the motor is large enough for the service without heating beyond a predetermined limit.

A. E. L.

636. *Circuit-breaker for Induction Motors.* **A. Bianchi.** (Elettricità, Milan, 22. p. 21, Jan. 11, 1903.)—In order to reduce the amount of high-tension apparatus required for high-tension induction motors, the author has designed a minimum current cut-out for placing in the rotor circuit of such motors. Owing to the low frequency of the rotor current, it is found necessary to use a triple-cored magnet, wound with all three phases, so as to avoid breaking the circuit every time the current in any one phase passes through zero. For the same reason this core need not be laminated. Such circuit-breakers have been in successful use for over a year. A. E. L.

637. *Induction Motor Characteristics.* **A. S. M'Allister.** (Amer. Electn. 15. pp. 15–17, Jan., 1903.)—For given values of the magnetic flux and secondary current, the only effect of inserting resistance into the secondary of an induction motor is to increase the slip in direct proportion to the resistance, everything else remaining unaltered. Hence the behaviour of the secondary will be faithfully represented if all the power received by it from the primary be considered as dissipated entirely in a suitable resistance inserted in the secondary circuit, this equivalent resistance being so chosen as to make the slip equal to unity. Thus the induction motor may be treated in all respects like a stationary transformer. The author shows how the losses, output, efficiency, slip, speed, power-factor, and apparent efficiency may be determined from the curve which represents the locus of the extremity of the primary current vector; this curve may be taken to be the arc of a circle for approximate calculations. A numerical example in illustration of the author's method is fully worked out. A. H.

Digitized by Google

638. *The Cooper-Hewitt Rectifier.* (Electrician, 50. pp. 509–511, Jan. 1 1903.)—The rectifier is developed from a study of the peculiarities of the mercury vapour lamp [see Abstracts Nos. 1880 (1901) and 622 and 799 (1902)]. It is intended to be used with three-phase alternate current. It consists of a vacuum bulb, having a single negative electrode at one end; at the other end are four positive electrodes, one for each phase of the three-phase current, and one to be connected to continuous current for the purpose of starting. Owing to peculiarities of a mercury vapour column, the current can only pass in one direction; consequently, only alternations on one side of the zero line pass between the electrodes, those on the other side being suppressed, and therefore absorbing no power. The rectifier is started by continuous current, and then glows like a mercury vapour lamp. The various phases of the alternate current are then connected up, and when the continuous current is disconnected, the lamp continues to glow, and continuous current passes between the electrodes. If the voltage falls below a critical value, the rectifier ceases to work; hence it does not work on single-phase alternate current. The converter is said to be available for all voltages between 100 and 1,000, and can carry 100 amperes. The loss of power is due to a constant fall of 14 volts within the bulb. Hence at 140 volts the loss is 10 per cent., and at 1,000 volts 1·4 per cent. W. H. S.

REFERENCES.

639. *Drum Armature End Connections.* **J. Dalemont.** (Assoc. Ing. Él. Liége, Bull. 2. pp. 428–465, July, Aug.-Sept., Oct., 1902.)—The author describes methods of calculating the lengths of end connections of drum armatures. R. B. R.

640. *Methods of Testing the Efficiency of Dynamos.* **E. Pierard.** (Assoc. Ing. Él. Liége, Bull. 2. pp. 419–427, July, Aug.-Sept., Oct., 1902.)—The author discusses Swinburne's method of testing the efficiency of a dynamo by running it as a motor; Housman's method of separating the friction and hysteresis losses from the eddy current losses; and Bienaimé's method of testing at three lower voltages, when the voltage available is not sufficient to drive the motor at full speed. [See also Abstract No. 2272 (1901)]. R. B. R.

641. *The Manufacture of Toothed Armature Plates.* **R. Hundhausen.** (Elektrotechn. Zeitschr. 23. pp. 1095–1098, Dec. 18, and pp. 1130–1133, Dec. 25, 1902.)—The author describes some automatic machines used by Siemens and Halske for stamping armature plates. For details, the original articles must be consulted. W. H. S.

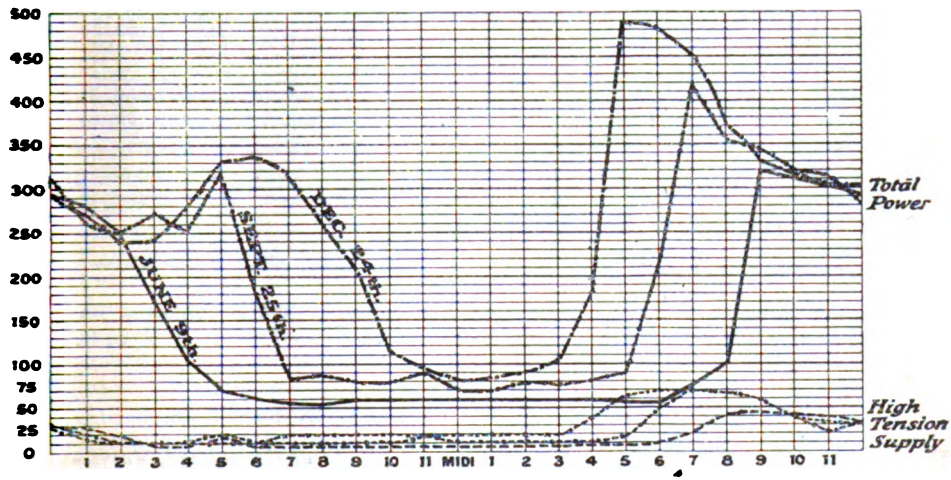
642. *Voltage Drop in Transformers.* **M. Breslauer.** (Zeitschr. Elektrotechn., Wien, 20. pp. 523–526, Oct. 26, and pp. 573–575, Nov. 23, 1902.)—The author shows how Heyland's diagram for an induction motor may be modified so as to render it applicable to a transformer, and how by its use the regulation curve of the transformer may be determined for a load of any given power-factor. A. H.

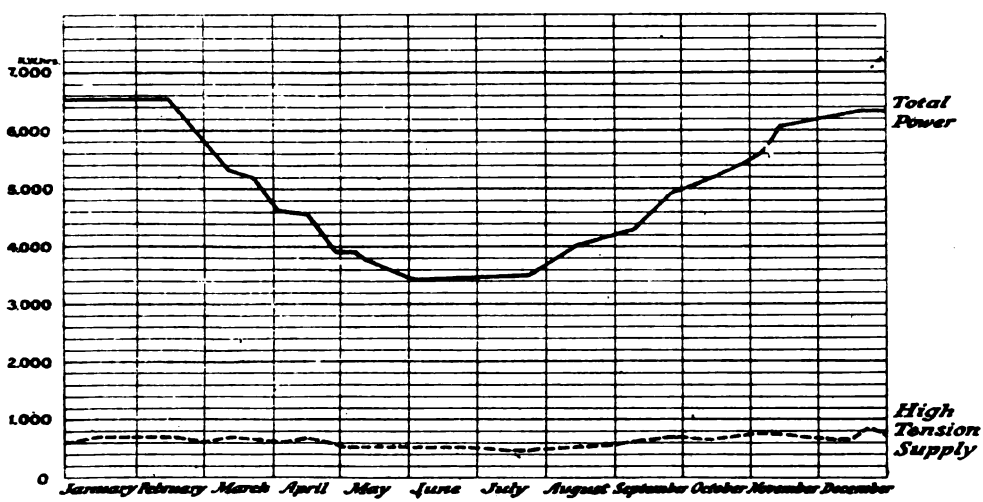
Digitized by Google

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

643. *Statistics of the Operation of the "Secteur Municipal" in Paris in* 1901. **Lauriol.** (Soc. Int. Élect., Bull. 8. pp. 10–15, Jan., 1908.)—The paper con-

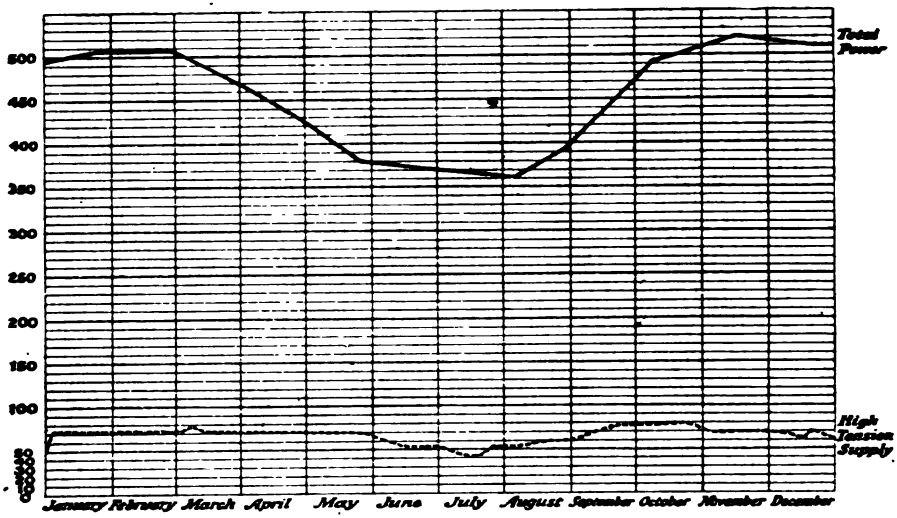




sists essentially of a series of four diagrams relating to the supply and consumption of electricity for lighting and other purposes in Paris in the year

Digitized by Google

1901. Three of these diagrams are reproduced here, and are self-explanatory. The lighting of the public buildings and streets falls chiefly on the low-



tension network, and the high-tension distribution system is employed for the private-house supply in the suburban districts. J. B. C. K.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

644. *The Central Electric Supply Company's Works at Grove Road, Marylebone.* (Elect. Engin. 81. pp. 42–47, Jan. 9, 1908.)—This company was formed to supply electrical energy in bulk to the Westminster and St. James's and Pall Mall Electric Light Companies. The site will accommodate about 54,000 kw., of which the first section of buildings, now practically completed, will contain plant with an output of about 9,000 kw. The boiler-house is 90 ft. by 110 ft., and will contain fourteen boilers of the "Climax" water-tube type, each capable of evaporating 26,000 lbs. of water per hour. Eight of these have been already erected. The grate area is 127·5 sq. ft. and the heating surface 6,901 sq. ft. The engines are of the Willans and Robinson high-speed type, non-condensing. They are triple expansion, working at 190 lbs. steam pressure, and can stand an overload of 20 per cent. Two of these are of 2,400 i.h.p., another of about half the capacity, and two more of the larger sizes are contemplated. The alternators are three-phase, of the "Oerlikon" design and manufacture, generating at 6,000 volts. The frequency will eventually be 50, but at present the machinery is being run slower in order to obtain a frequency of 40, which is found convenient in consequence of certain details of the three-phase plant at Eccleston Place. The generators have stationary armatures and revolving field magnets, and a heavy flywheel has been added in order to improve the parallel running. The regulation is guaranteed to be such that at constant speed and excitation the drop is not more than 6·7 per cent. on a noninductive load and 18·8 on a load with a power factor of 0·85. The governors of the engines are controlled from the switchboard by means of small motors. The revolving parts of the larger sets weigh 75 tons. The exciters, which are carried on the main shafts, are

Digitized by Google

4-pole, shunt wound, generating at 200 volts. Two direct-driven machines, each coupled to a high-speed engine, act as a stand-by. These also supply batteries of 110 Tudor cells with a capacity of 150 amperes for three hours, or 850 amperes on a one-hour discharge for works lighting, and to supply power required for the cranes, &c., in the station. The switchboard is by Messrs. Siemens Bros. & Co., but was not erected when the paper was written. A somewhat novel method of charging up and discharging the feeders is employed, a small subsidiary plant being used, driven off the direct-current station service, to bring up the voltage on the feeders through a transformer, until the proper pressure and frequency is reached, when the main generators are thrown into parallel. Thus all danger from resonance effects is eliminated. The article contains drawings showing a plan and cross sections of the works, and the general design of the engines, boilers, and pipework, &c.

B. P. S.

645. *Barnstaple Electricity Works.* (Elect. Engin. 31. pp. 186–189, Feb. 6, 1903.)—System: Three-wire direct current at 230 and 460 volts. The boiler-room contains three Babcock and Wilcox boilers, each capable of evaporating 5,000 lbs. of water per hour, and fitted with superheaters giving a temperature of 500° F. The feed water is heated by a Green economiser. The coal is fired by hand. The engine-room contains three vertical compound enclosed three-crank engines made by Messrs. Reavell & Co., running at 450 r.p.m. There is a single surface condenser for all the exhaust steam. Each engine drives direct a dynamo of 125 kw. output at 500 volts, made by the Newton Electrical Works, Ltd. There is also a booster-balancer set. Feeders of the St. Helen's Cable Co.'s Dialite insulated type, each comprising three separate cables, are laid on the solid system, with spare ducts of stoneware for future extensions. Distributors of the same type, 0·125, 0·062, and 0·125 sq. in. in cross section, are provided, with special cables for street lighting. The station is equipped with a 240-cell battery of accumulators made by Messrs. Ashmore, Benson, Pease & Co. The equivalent of 4,000 8-c.p. lamps is connected. The price charged is 6d. per unit for lighting and 3d. per unit for power, the flat rate system of charging being in force.

A. H. A.

646. *Manchester (Bloom Street) Electricity Works.* (Electrician, 50. pp. 672–675, Feb. 13, and pp. 715–719, Feb. 20, 1903.)—System: Direct current for lighting and traction, at 440 and 500 volts respectively. The boiler-room contains eleven Babcock and Wilcox boilers, each having a heating surface of 5,140 sq. ft., and an evaporative capacity of 18,000 lbs. of water per hour, at a working pressure of 160 lbs. per sq. in. The boilers are fitted with superheaters, each having a heating surface of 460 sq. ft., and raising the temperature of the steam about 90° F. The feed water is heated by a Green economiser of 160 tubes to each boiler, arranged over the top of the latter. Coal is stored in bunkers above the economisers, of 650 tons capacity, and is fired by Babcock chain grate stokers. The engine-room contains four vertical compound Musgrave engines, each having cylinders 38½ and 76 in. in diameter, with a stroke of 54 in., and giving 8,000 i.h.p. at 75 r.p.m. Two Mather & Platt surface condensers are provided for each engine. Each engine drives direct a Westinghouse dynamo, of 1,800 kw. capacity, generating at 410 to 440 volts for lighting and 500 volts for traction. The main switchboard is connected with that in the adjoining Dickinson Street station, and controls 28 traction and 24 lighting feeders. The traction feeders are of Messrs. Callender & Glover's make, having a cross-section of 0·5 sq. in.

Digitized by Google

each. The track is equipped on the overhead trolley system, and comprises about 100 miles of single track. The trolley wire is of No. 0000 S.W.G. hard-drawn copper. The rails are of the girder type, weighing 102 lbs. per yard, and are tied together by 2 × ⅝ in. ties. The fishplates weigh 64 lbs. per pair, and the joints are bonded with one short flexible and two long bonds. The foundation of the track is of concrete, 6 in. thick and 18 in. wide under each rail. The track is paved with granite setts. There are 310 motor cars fitted with various types of trucks, motors, and series parallel controllers. The motor cars have a capacity of from 45 to 79 passengers. The article is accompanied by numerous drawings and other illustrations. There is also a description of two Parsons 1,800 kw. turbo-generators in Dickinson Street Works. [See also Abstracts Nos. 1594 (1901) and 801 (1903).]

A. H. A.

647. *Electrical Distribution at Manchester, N.H.* (Elect. World and Engineer, 41. pp. 105–109, Jan. 17, 1903.)—Electric light, power, and traction at Manchester, in New Hampshire, demands more water power than any other city in New England. The system has already been described. [See Abstract No. 1815 (1901).] The present article deals with some later developments and special features. The total capacity has now reached 4,080 kw. The installation at Garvin's Falls, the largest of the stations, is first considered. Water reaches the station through a canal which gives a maximum head of about 30 ft. above the backwater of the river. The fore-bay wall of this canal forms one side of the wheel-room of the station, and next this wheel-room is the space allotted to the generators and switchboard. Three wheel-cases communicate with the canal water by passing through the fore-bay wall. From each wheel-case two draught tubes extend down to a level 30 ft. below that of the canal water. The generator room is 15 ft. below the level of the canal floor. The outside walls of the station are water-proofed inside to a height of 8 ft. above the floor of the generator room, and outside to a height of 2¼ ft. above the level of the notable flood of 1896. As shown by the drawings and photographs, the water, after leaving the draught tubes, passes directly beneath the generator room, and then into the river. Water is admitted into the wheel-cases by a 5-h.p. induction motor located in the gate-house at the top of the wall. Two of the wheel-races contain each three Rodney-Hunt turbines running at 180 r.p.m., the three together being rated at 1,000 h.p. The third wheel-case contains a pair of 12-in. wheels of the same type, running at 600 r.p.m. Each wheel-shaft extends through a water-tight bushing into the generator room, and the shafts of the larger wheels are connected with the shaft of a 650-kw., 120-volt, 60-cycle, three-phase revolving-magnet alternator. The shaft of the 12-in. wheels is directly connected to that of a 400-ampere, 125-volt generator used as an exciter. Another exciter is run by a 75-h.p. induction motor. Each of the three sets of water wheels is regulated in speed by a Lombard governor belted to the shaft of the connected dynamo. The switchboard is of marble, and has a wooden frame treated with chemicals so as to give it slow burning properties. To avoid the effect of fluctuating traction loads on the voltage of the lighting system, the plan involving double sets of bus bars has been carried out in all the water-power stations and at the substation. This plan enables any generator, or any transmission line in the entire system, to be operated exclusively for either lighting or traction work. The practice is to devote one set of bus bars to traction loads in all the plants alike, reserving the other set of bus bars for general electrical supply. Since all the stations and offices of

Digitized by Google

the lighting and traction system are connected by telephone, the person in charge can shift any generator or transmission line from one class of work to the other. Between the Falls and the substation at Manchester are two three-phase lines operated at 11,000 volts. The substation is now complete. It contains twenty-one 200-kw. air-blast transformers. In addition to the six wires from the Falls, thirteen other wires enter the substation from other power stations. Two of the circuits are for the Kelley's Falls, which are transmitted as two-phase. The method of switching is described with the help of three photographs. The general nature of the load, and the distribution circuits, are described in detail. W. W. H. G.

648. *Cardiff Electric Tramways.* (Elect. Engin. 29. pp. 1–16 (Supplement), and pp. 690–698, May 16, 1902.)—The power-house contains ten Lancashire boilers, 30 ft. by 8 ft., working at 160 lbs. pressure. They are fitted with Vicars mechanical stokers, into which coal is fed from overhead bunkers. The steam piping is arranged on the ring principle. It is brought down the centre of the engine-room, and there divided into two mains, which are interconnected at their ends, and at the middle have large expansion bends. The engine-room contains four 300-kw. generators, running at 100 r.p.m., and coupled to vertical Musgrave engines. It also contains a motor-generator, which is used either for lighting the station and car shed, or for charging a battery of accumulators; it can also be run as a motor from the battery, thus generating 500 volts, the output being available for line-testing purposes, or for shunting cars in the shed when the station is shut down. The battery consists of 56 Tudor cells, giving 210 amperes for 10 hours. The tramway track is laid on a concrete foundation, 8 in. deep, with an extra depth of 3 in. under the rails, and for 6 in. on either side of them. The rails weigh 100 lbs. per yard, are 6¼ in. in depth, and have a groove 1¼ in. wide and 1¼ in. deep. The rail joints are strengthened by sole plates, and have plastic bonds. There are seven positive feeders; five have areas of 0·6 sq. in., the other two being of 0·5 and 0·4 sq. in. respectively. There are also two negative feeding points; to the one two cables are run, each of 0·6 sq. in. area, and to the other three cables, two of 0·8 and one of 0·6 sq. in. All cables are lead-covered, and drawn into conduits. The double-deck bogie cars seat 30 passengers inside and 38 outside; the single-deck cars seat 34 passengers. Dimensions of these cars are given. The article contains a large number of drawings. W. H. S.

649. *Bournemouth Corporation Electric Tramways.* (Elect. Engin. 31. pp. 78–86, Jan. 16, and Supplement, pp. 1–5, Jan. 23, 1903.)—The system is a combination of the conduit and the trolley systems. The boiler-room contains four "Danks" Lancashire boilers each 30 ft. by 8 ft. 6 in.; Schmidt superheaters are fitted, capable of superheating 30,000 lbs. of steam per hour to 500° F. at a pressure of 180 lbs. per sq. in. The feed water is heated by Green's economisers, consisting of 384 tubes arranged in three groups, each coupled together by copper expansion elbows. The heating surface is about 4,000 sq. ft. Coal is stored in a receiving hopper and distributed to the boilers by a conveyor, and is fired by mechanical stokers. The ashes are also dealt with by the conveyor. The engine-room contains four steam sets, consisting of Belliss engines of the three-crank triple-expansion type with cylinders 12½ in. by 18½ in. and 28 in. diameter by 12 in. stroke. The dynamos are of the B.T.H. 8-pole type, each having an output of 330 kw. at 550 volts at 360 r.p.m. The full-load output is 662 amperes at 500 volts, and the machines are compound wound to give a constant pressure of 550 volts between 50 and

Digitized by Google

662 amperes. The engines exhaust into surface condensers capable of dealing with 15,000 lbs. of steam per hour and giving a vacuum of 29 in. A Klein cooling tower is erected capable of dealing with 100,000 gallons of water per hour and reducing the temperature to 80° F. The air circulation is by natural draught. Feeders: There are two conduit and five trolley line feeders, varying in size from 0·188 to 0·31 sq. in. section, and two 0·1 sq. in. return rail cables. The cables are paper insulated and lead sheathed, and drawn into stoneware conduits. The track is equipped on the side slot conduit and overhead trolley system. The slot is 1 in. wide, and the depth of the conduit is 2 ft. and its width 14½ in. The conductors are 14¾ in. from the top of the slotway, and are 6 in. apart from face to face. The insulators supporting the conductors are spaced 15 ft. apart, and the conduit yokes are 8 ft. 6 in. from centre to centre. The rails are laid to a 3 ft. 6 in. gauge and weigh 100 lbs. per yard. At points and crossings, the contact rails are interrupted for a distance of 12 to 15 ft. The points are specially heavy, being 12 ft. long. There are two types of motor cars, viz., double-deck bogie and double-deck single-track cars. The cars have a capacity of 60 and 40 passengers respectively. Drawings of the generating station, piping, coal and ash conveyors, cars, conduits, &c., are given, also many photographs. F. B.

650. *Lancaster Electric Tramways.* (Tram. Rly. World, 13. pp. 127–132, Feb., 1903.)—System: Overhead trolley wire, single track with turnouts. The boiler-room contains five Lancashire boilers, working at 135 lbs. per sq. in. The feed water is heated by a Green economiser of 190 tubes. Coal is stored in a small bunker in the boiler-house, and is fired by hand. The engine-room contains, in addition to the old lighting plant of 630 kw., four enclosed vertical compound three-crank Belliss engines, each provided with a Körting ejector condenser. Each engine drives direct a Westinghouse dynamo, two being of 200 kw. output each, and running at 420 r.p.m., while the other two are of 300 kw. output, and run at 375 r.p.m. The working pressure is 550 volts for traction and 460 for lighting. There is also a motor-generator of 60 kw. Feeders of Callenders' make are used, those for traction being drawn into Sykes conduits, while the lighting feeders are laid in bitumen. The track is equipped on the overhead trolley system, and has a length of 3 miles 1 furlong. Steel poles carry by means of bracket arms trolley wire of No. 000 hard-drawn copper insulated by Ætna insulators. The rails are of the girder type, weighing 90 lbs. per yard, gauge 4 ft. 8½ in., tied together by tie bars 7 ft. 6 in. apart. The fishplates weigh 36 lbs. per pair, and anchor plates are used under the joints, which are bonded with two No. 0000 Chicago Crown bonds each. The foundation of the track is concrete 6 in. thick. The track is paved with setts. There are 10 motor cars fitted with Brill trucks, each carrying two Westinghouse motors, No. 46, and series-parallel controllers. Drawings: Plan and sections of track and power-station, and photographic views. A. H. A.

651. *Three-phase Installation in Sugar Factory.* (Elect. Rev. 52. pp. 48–51, Jan. 9, 1903.)—The installation described is in a Bohemian cube sugar factory, which has a possible output of 18 to 30 tons of assorted cubes per day. The generator is of the revolving field type coupled directly to a steam-engine running at 200 r.p.m. The magnet wheel is of cast steel and carries 30 poles of oval section. The frequency is 50, and the output 120 (true) kw. at 200 volts. The stationary armature is built up of stampings 16 mils thick, and the windings are carried in 180 partially closed slots, and consist of

Digitized by Google

copper bars insulated from the iron by micanite troughs. The windings are connected up in star form. The efficiency at full load, including generator and exciter losses, is 94 per cent.; and the temperature rise after 7½ hours full-load run was 21° C. for the magnet copper, and 22° C. for the armature copper. The driving of the centrifugal drying machines forms the chief part of the load and necessitated a special construction of motor. The centrifugal drum with its contents had to be accelerated up to full speed in 6 minutes, and as an attendant could not be expected to gradually cut out starting resistance during this period, the machines are switched directly on to the mains without resistance, the rotors being of the short-circuited type. The initial current per phase is 80 amperes, corresponding to about 15 kw., and the full-speed current is 18 amperes, or about 5·8 kw. The power factor rises from 60 to 91 per cent. On account of the sudden rush of current at starting no soldered connections are employed in the rotor. Curves of no-load characteristic and short-circuit current are given, also curves showing the starting performance of the motors. Illustrations of the stator and rotor of the motor, also section through the centrifugal machine, are given. F. B.

652. *The Electrical Installation at the Hoboken (Belgium) Metallurgical Works.* **van der Wallen.** (Assoc. Ing. Él. Liége, Bull. 2. pp. 605–633, Nov. and Dec., 1902.)—A very lengthy and detailed description is given (illustrated) of the electrical plant recently installed at the steel and iron foundry and rolling mills at Hoboken, in Belgium. The electric power is supplied by the Compagnie Industrielle d'Électricité, and a description of the generating plant at their station is also included in the article. The special feature of the applications of electric power in the metallurgical works, is the use of direct-coupled motors for driving the rolling mills. The Westinghouse Company have designed the whole of the plant, and supplied the electrical equipment for the metallurgical works. The results obtained with this application of electric power at Hoboken have been so satisfactory that the Société des Acéries et des Tôleries d'Anvers, and other large metallurgical companies in Europe and America, have decided to employ electric motors for further extensions of their rolling-mill plants. In fact, for all the secondary apparatus and machinery of large foundries and rolling mills, electric power has proved to be more convenient and economical than steam power; and the change from one system of driving to the other at Hoboken is likely to be followed by similar changes in the metallurgical works of Europe and America. J. B. C. K.

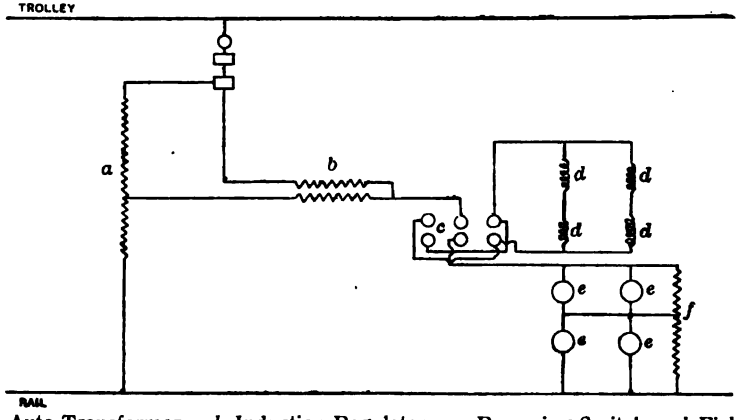
653. *Electrically-driven Cotton Mill.* **J. A. Montpellier.** (Électricien, 25. pp. 33–39, Jan. 17, 1903.)—The cotton-spinning company of Mirecourt decided to adopt electricity as the motive power, before the factory was built, the estimated costs of mechanical and electrical driving machinery being nearly equal, while the electric drive presented a distinct advantage in efficiency and coal consumption, with reduced costs of maintenance, and greater uniformity of speed. The generating plant consists of a three-phase alternator coupled direct to a tandem compound engine of 600 h.p., and giving a pressure of 400 volts at 100 r.p.m., 50 cycles per second. The alternator is of the magnet-flywheel type, with tunnel armature; the latter is wound with cylindrical rods of copper in holes of the same shape. The magnetic system is excited either by means of a storage battery or by a motor-generator. The motors are fed with current at 400 volts, while incandescent lamps of 230 volts are used grouped star-fashion. The motors

Digitized by Google

are asynchronous, with short-circuited rotors, and range between 11 and 100 h.p.; they are geared to shafting by belts, thus driving the spinning and weaving machines in groups, and are fixed outside the rooms or in recesses as far as possible in order to save space and to avoid risk of fire. The machinery is set in motion by exciting the alternator and closing all the switches before starting the engine, producing the same result as with a mechanical drive. In case of accident the motor affected is shut down until repairs are effected; the engine is then stopped, the switches closed, and the whole works started up again immediately. Thus no starting gear for the individual motors is required. The article is illustrated. A. H. A.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

654. *An American Single-phase Railway.* **B. G. Lamme.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1231–1246, Aug.–Sept.; Discussion, pp. 1487–1452, Nov., 1902.)—The line in question runs from Washington to Baltimore, a distance of 31 miles, with a branch line to Annapolis, a distance of about 15 miles. The main advantages of the direct-current system have been the use of the series motor, and of a single overhead trolley line. Its defects are numerous; the speed control is inefficient, and at starting the losses are heavy; the controller is liable to be a source of trouble; the voltage cannot be much increased, and probably all existing railway equipments would be unsafe if used on 700 volts; in heavy railway work, the current to be



a Auto-Transformer. *b* Induction Regulator. *c* Reversing Switch. *d* Field of Motors. *e* Armature of Motors. *f* Equalising Transformer.

collected becomes enormous, and the risks from electrolysis cannot be neglected. With an alternate-current system, many of these defects disappear. Voltage control can be obtained in several ways. The use of transformers being assumed, a number of leads can be brought out from various points on the winding and taken to a dial; this is the method of the Stillwell regulator. It becomes unsatisfactory when heavy currents have to be handled. Another method is that of the so-called induction regulator, which is a transformer with primary and secondary windings on separate cores, the voltage in the secondary being varied by shifting its angular

[1] Non-electrical Automobiles are described in the section dealing with steam and gas engines.

Digitized by Google

position with regard to the primary. In construction, it resembles an induction motor, the primary being wound on the rotor, and the secondary on the stator. The regulator is wound with two poles, so that the full range of voltage is produced by turning the rotor through 180°. The secondary voltage of the regulator can be either added to or subtracted from the main transformer voltage. On the Washington Railway, the voltage at the motors is to be varied from 200 to 400 ; the transformer on the car supplies 315 volts, and the secondary voltage of the regulator gives a maximum of 100 volts. The motors are to be single-phase series motors with commutators and laminated field magnets. Current is delivered to the main transformers at 1,000 volts and 16⅔ cycles per second. The connections on the car are shown by the appended drawing. Each car has four motors of 100 h.p. ; the full voltage of each motor is 220 volts ; the motors are arranged in two pairs, each consisting of two armatures in series, and two fields in series, and the two pairs are permanently connected in parallel. The motor has 8 poles, and the speed is 700 r.p.m. The efficiency falls from about 89 per cent. at 50 h.p. to 86 per cent. at 120 h.p. ; similarly the power factor falls from 0·92 to 0·82. The power factor falls with increase of load, because the power developed increases in proportion to the current, while the wattless component of the input increases as the square of the current. The loss in the return rail with 2,000 alternations per minute is about three or four times as great as with an equal direct current ; but the current required will be less than with a direct-current system ; added to which, the rail loss with direct current is kept low to avoid electrolysis, and not in order to lessen the waste of power. Lighting of cars with current at 16 alternations per second is arranged either by split-phase methods, two filaments being enclosed in one bulb, or by using very low voltage lamps in series, when the heat inertia of the thick filaments causes the light to be steady. The main power station will generate current at 15,000 volts ; this is supplied to nine transformer substations, which will supply 1,000 volts to the trolley wire. *In the discussion*, **C. P. Steinmetz** pointed out that the 16-cycle motors run at a speed corresponding to 47 cycles, *i.e.*, nearly three times the speed of synchronism ; consequently the power factor is good. He preferred, however, the Thomson repulsion motor, in which the field is directly connected across the supply circuit, the armature is short-circuited on itself across the brushes, which are set at an angle of about 45° from the ordinary neutral point. **B. J. Arnold** pointed out that the main difficulty with series motors of the kind described in the paper was to get them to start under load without sparking, and it would remain to be seen whether under working conditions the sparking became serious. In reply to questions, the Author said that the Thomson repulsion motor seemed more complicated, as its direction of rotation could not be so easily reversed ; it also seemed likely to be heavier. The power factor does not depend only on the number of poles, but rather on matters of general design. By increasing the number of poles, the power factor is probably somewhat improved, but the difference is not great. The air-gap in the motors is about the same as in smaller direct-current motors ; and the brushes, being on the neutral point, do not need to be shifted when reversing the direction of rotation. Other questions with regard to constructional features were left unanswered. W. H. S.

655. *Brake Tests and Deductions therefrom.* **J. D. Keiley.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 13–27 ; Discussion, pp. 70–87, Jan., 1903.)—The paper is descriptive of a method of making brake tests, and of a recording

Digitized by Google

apparatus used. Results from tests on a number of different kinds of brakes are given, and an empirical formula is deduced showing the operation of these brakes under various conditions. In all the tests the same type of car was used, mounted on similar trucks, and all equally loaded. The cars were run in the same direction, over the same track, and great care was taken to accurately determine the speed of the car at brake signal and the actual distance traversed between the brake signal and the stopping of the car. An illustrated description of the recording apparatus is given, and several speed and distance curves, from which T and R may be obtained. T = time from brake signal to application of brake shoes, and R = rate of braking in miles per hour per second from setting of brake shoes to stop. One practical result obtained was the reduction by about 18 per cent. in the distance required to stop a car, by the use of non-equalising levers, applying to the front truck a braking pressure exceeding that applied to the rear truck, in a certain pre-determined ratio. F. B.

656. *Guard Wires on Electric Tramways. The New Board of Trade Regulations.* (Tram. Rly. World, 13. p. 145, Feb., 1903.)—*Previous Regulation now Superseded.* Efficient guard wires shall be erected and maintained at all places where telegraph or telephone wires cross above the electric conductors of the tramways. *New Regulation.* If and wherever telegraph or telephone wires, unprotected with a permanent insulating covering, cross above, or are liable to fall upon, or to be blown on to, the electric conductors of the tramways, efficient guard wires shall be erected and maintained at all such places. An explanatory memorandum follows, with diagrams showing the number and position of the guard wires necessary for different arrangements of trolley wires. F. B.

657. *The Putnam and Webster and the Miller Automatic Electric Block Systems of Railway Signalling.* **L. Kohlfürst.** (Zeitschr. Elektrotechn., Wien, 20. pp. 617–621, Dec. 14, 1902.)—In the Putnam and Webster system the line is divided into block-sections, s_2S_2, s_3S_3, s_4S_4, s_5S_5, ..., and, in the

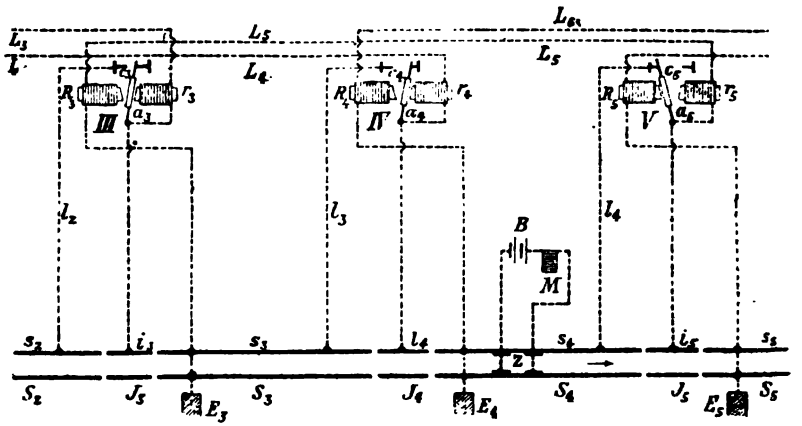


Fig. 1

ordinary track, pairs of well-insulated rails, i_3J_3, i_4J_4, i_5J_5, ... are introduced between the several block-sections, one of each pair of insulated rails being connected to the armature or tongue a_3, a_4, a_5, ... of a two-coil relay r_3R_3, r_4R_4, r_5R_5, ..., and through the right-hand coil, *e.g.*, r_5 of the corresponding

Digitized by Google

relay, *e.g.*, R_5r_5, to the left-hand coil, *e.g.*, R_3, of the relay two block-sections behind. The position of the tongue shown at V, Fig. 1, corresponds to "line clear." On the train, Fig. 2, the locomotive and tender are insulated from each other, and there is an electric generator B, and signalling device M with a resistance *w* between the locomotive Q and the tender P, so as to be normally short-circuited by the rails S. A second electromagnet M_1 is provided, of which the armature, when attracted, opens the valve of the air-brake of the train. Current only passes into the coils of the magnet M_1 when the magnet M is de-energised and has its armature A drawn back by a spring. A switch K, controlled by a handle H, enables the magnet M_1 to be de-energised by the driver. Thus, when the section s_5S_5 into which a train Z enters, Fig. 1, is clear, i_5 will be short-circuited to s_4 through the relay-tongue a_5, contact c_5 and wire l_4 and the magnet M will remain energised; when P reaches i_5 and Q reaches s_5, the circuit of M will still be completed through r_5, L_5, R_5 and the earth-connections E_3 and E_5, and at the same time the tongue a_3 will be moved to the left into the "line clear" position, and the tongue a_5 to the right into the "line blocked" position. If, however, another train passes on to i_4 or i_5, Q

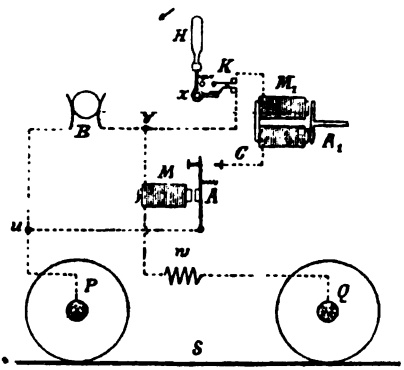


Fig. 2.

will be insulated from P, and therefore M will be de-energised and M_1 energised to automatically apply the brake.

In the Miller system, Fig. 3, the track is divided up similarly to the track in the Putnam and Webster system, but in the present case the short insulated sections *i*, J, ..., are connected together and to one pole of a battery B_1 . . . . through a reversing switch A, *p*, *q*, *u*, *v*, *y*, ..., the other pole of this battery being connected to the rails of the block-section behind the respective insulated section of rails. The reversing switch is controlled by two relay-magnets M, R, ... which each have one end of their coils connected to the rear end of one (S) of the rails of the block-section in advance of the respective insulated section, the forward end of each block-section having a battery *b*, ... permanently connected across the rails, whilst the other end of the coil R . . . . is connected to the rear end of the other rail (*s*), and the other end of the coil M . . . . is connected, through the relay-levers and contacts *a*, *c*, c^1, *n*, ... with the respective insulated section of rails and with the corresponding relay of the block-section in advance. When either of the coils M, ... or R . . . ., is de-energised, due to the short-circuiting by a train of the rails of the second or first block-sections in advance respectively, the reversing switch A, *p*, *q*, ... will be thrown over and the battery B . . . . will

Digitized by Google

send its current in the reverse direction. This current passes into coils on the train connected between three successive pairs of wheels insulated from each other, so as to actuate a two-way switch, whereby either a pair of white lamps or a pair of red lamps is illuminated from an accumulator on the train, accord-

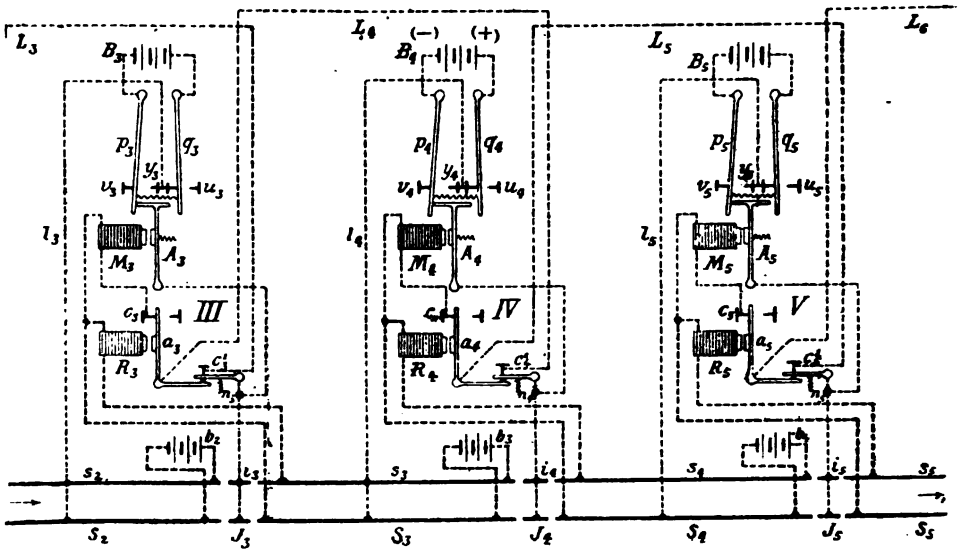


Fig. 3.

ing as the battery controlled by the switch A, p, q, ... sends its current in one or the other direction. This system has the additional advantage of indicating "danger" when the rails are damaged or interrupted by the opening of a switch (mechanical). C. K. F.

REFERENCES.

658. *Hot Water Heating from a Central Station.* **E. H. McKnight.** (Elect. World and Engineer, 40. p. 708, Nov. 1, 1902. Paper read at the 8th annual meeting of the Ohio Electric Light Association.)

659. *Electricity Supply in Paris in* 1901. **Lauriol.** (Soc. Int. Élect., Bull. 3. pp. 16–18, Jan., 1903.)—A diagram is given showing the distribution of electrical energy in Paris in the year 1901, with some explanatory remarks. J. B. C. K.

660. *Draw-bar Pull Rating of Engines.* **H. A. Fergusson.** (Railroad Gazette, 34. pp. 960–961, Dec. 19, 1902. Abstract of paper read before the North-West Railway Club, Oct., 1902.)—The author gives a diagram of drawbar pull for cars of from 10 to 75 tons on the level.

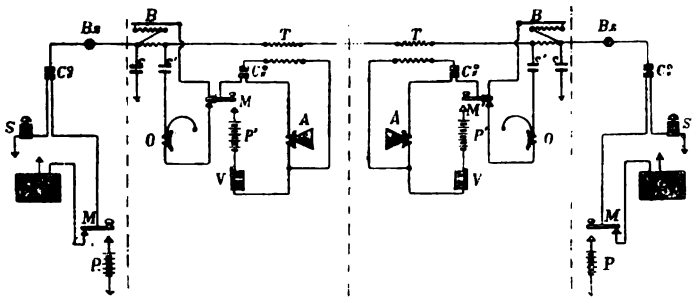
661. *Girder Rail Design.* **S. Grant.** (Tram. Rly. World, 13. pp. 133–137, Feb., 1903.)—Some notes on the design of girder rails for tramways, illustrated by dimensioned sectional drawings. F. B.

662. *Guard Wires on Electric Tramways.* (Tram. Rly. World, 13. pp. 164–171, Feb., 1903.)—Report of Conference on above at Board of Trade on June 20, 1902. F. B.

Digitized by Google

TELEGRAPHY AND TELEPHONY.

663. *Van Rysselberghe Telegraph System.* (Journ. Télégraph. 27. pp. 9–10, Jan., 1908.)—Van Rysselberghe has shown that the diaphragm of a telephone remains silent to the effect of currents of sufficiently low periodicity. Petit of Tours makes use of this principle for superposing one set of telegraph signals upon another. The first set corresponds to an alternating current system, and causes the diaphragm of the telephone to emit sounds of short or long duration, which can be interpreted as dots and dashes. The second



set corresponds to an ordinary Morse system; it is suggested that this could be replaced by a Hughes system. This method has been working for six months, between Tours and Chinon and also between Tours and Loches. The arrangement is indicated by the figure. The key M' is divided where shown, by an insulating piece. The bobbin B is wound differentially, the resistance of the two circuits being adjusted according to the resistance of the line. The telephone O is the receiver; A is a buzzer used for calling up. V is a vibrator, and Bs is an inductance coil. R. A.

664. *Louis' Electric Carrier-call System.* (Elect. World and Engineer, 41. pp. 43–44, Jan. 3, 1908.)—In this system, each tenant in a large building is provided with a set of metal discs each having a number corresponding to the tenant. The discs in each set are of different diameters corresponding to the different carrier-companies to be called, and are marked accordingly, and each tenant has a chute leading to a distributor, *e.g.*, on the ground floor, which consists of a slightly inclined chute having a series of perforations corresponding to the several sizes of disc. Each perforation opens into a separate box having a counterbalanced movable bottom, so that when a disc enters it depresses the bottom and completes a relay-circuit controlling the circuit of an indicator arranged outside the building whereby the name of the particular carrier is displayed. The driver thus called enters the building and opens the box bearing his company's name, and discovers from the number on the disc which tenant requires his services. The original paper contains photographs of the apparatus used and gives some details of its construction. C. K. F.

665. *Long-distance Telephone Lines.* **F. Dolezalek** and **A. Ebeling.** (Elektrotechn. Zeitschr. 23. pp. 1059–1068, Dec. 4, 1902. See also Elect. Rev.

Digitized by Google

Dec. 12 and 19, 1902.)—Pupin, following on the work of Heaviside and S. P. Thompson, calculated the best position of the induction coils, and the best distance at which to separate them, with a view to eliminating the interference caused by reflected impulses. [See Abstract No. 2122 (1900).] In the present communication, experiments are described illustrating the value of the improvements introduced by Pupin. The theory of wave transmission is first given for the simple case of a line along which self-induction is supposed to be distributed uniformly with capacity. He then determines the effect upon the current function, of introducing the self-induction and capacity of the receiving and transmitting instruments. The result arrived at is an expression difficult to evaluate, for it involves the impedance at both ends of the line. Pupin, however, finds that he can deal with the case when it is assumed that the receiver has negligible impedance. In this case the current function appears as a combination of a cosine curve with a catenary. The most interesting point arising from the final equations is that if the inductance is so great that the ohmic resistance may be neglected, the periodicity factor likewise vanishes. The treatment of these equations by Pupin has resulted in the important conclusion that in a line with inductance intercalated at definite distances, the attenuation constant is reduced exactly as if the inductance were evenly distributed, provided that the distance between the points of their insertion is a fraction of a wave-length of the oscillatory current transmitted. This useful result is verified by practical improvement of transmission over lines dealt with as suggested by Pupin. The experiment was tried upon a 32·5 km. cable between Berlin and Potsdam, which contains 28 pairs of conductors. These were dealt with in two sets, each of 14 pairs, one set being equipped, and the other set not equipped with inductance coils. The coils in the equipped set were inserted at the alternate junction boxes, the distance from one inductance coil to the next being about 1,300 metres. Each coil introduced 4·1 ohms, and about 0·062 henries. The wire-to-wire capacity was about 0·037 mfd. per km. As a result the inductance was increased 200-fold, and the attenuation constant was reduced one-sixth. An enormous difference was noticed in loudness on the equipped line of 32·5 km.; and through 13 lengths in series, equivalent to 422·5 km., speech was still possible, though tones were weak.

[From the illustration accompanying the article, it appears that the inductance coils for the junction boxes were mounted together, fourteen in an iron box, on what appear to be iron rods. If this is the case, some of the improvement observed is probably due to induction from coil to coil. The effect would therefore, in all probability, be somewhat less if the 422·5 km. were on the straight, with each coil in magnetic isolation from all others.]

Very satisfactory results were obtained on the Berlin-Magdeburg overhead bronze 2 mm. diameter wire, of 150 km., as compared with a bronze 8 mm. wire of 180 km. to the same place. The equipped line of 150 km. fine wire gave louder speech than the other. The equipment consisted of coils inserted at every 4 km., each of 6 ohms and 0·08 henries. Quantitative tests were next made on these cables by means of an oscillograph, using an alternating current of 900 to 400 periods per second, and curves are given showing the current received at various periodicities through the equipped lines, under various conditions. Trans-Atlantic telephony is by these experiments brought within the limits of what is possible, and what is not far from practicable. R. A.

Digitized by Google

SCIENCE ABSTRACTS.

Section B.—ENGINEERING.

SEPTEMBER 1903.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

666. *Steam-Engine Tests.* (Engineer, 95. p. 192, Feb. 20, 1903.)—This is an account of the results of some sixteen trials by Schröter, of Munich, of a compound engine built by the firm of Van der Kerchove, of Ghent. The cylinders are 13 in. and 22 in. diameter by 33½ in. stroke, and the normal speed 127 r.p.m. Rated output 250 b.h.p. The trials were made at various loads and with both saturated steam and steam having various amounts of superheat. The lowest consumption was obtained with steam superheated from 180° C. to 358° C., and was 4·02 kg. (= 8·86 lbs.) per i.h.p.-hour.

H. R. C.

667. *Highly Superheated Steam.* **Ewing.** (Engineer, 95. pp. 186–187, Feb. 20, 1903.)—The author refers to his test of an engine using highly superheated steam on the Schmidt system, in which the best consumption was the remarkable figure of 9 lbs. of steam per i.h.p.-hour [see Abstract No. 604 (1903)], and inquires what may be the reason that an addition of about one-fifth to the heat which the steam has already taken up from the boiler enables it to do 50 per cent. more work. The gain in thermodynamic efficiency is relatively small. The answer, apparently, is that by using highly superheated steam one escapes in great part the two chief sources of loss in the action of saturated steam; these are: (1) the loss due to alternate condensation and re-evaporation in the cylinder, and (2) the loss which arises through leakage at the valves, pistons, and sliding surfaces generally, especially direct through leakage from the steam to the exhaust side of a slide valve. The first of these losses is well known. With regard to the second, Callendar and Nicholson have shown that however tight a valve may be when standing still, it will leak while running; a film of water finding its way from the steam side to the exhaust between the sliding faces. The wetter the steam the more serious will this leakage become. A case is cited where the consumption of steam of a triple-expansion engine having piston valves was reduced by 42 per cent. for the same output by substituting steam superheated to 575° F. for saturated steam. Highly superheated steam

Digitized by Google

enables comparatively small engines to compete in efficiency with those of the largest size, and permits of excellent results being obtained with two-cylinder expansion only; the engine referred to above was a two-cylinder compound of only 800 i.h.p. To obtain the full advantage it is necessary that the steam should be superheated before each expansion; that is, the steam in the receiver which has become saturated or even wet by expansion in the previous cylinder must be again superheated before admission to the next cylinder; this may be done by the live steam on its way to the engine, as in the case referred to above. H. R. C.

668. *Roberts' Water-tube Boiler.* (Mech. Eng. 11. pp. 251–252, Feb. 21, 1903.)—Illustrations are given of this boiler, which consists of a number of straight tubes inclined at a slight angle from the vertical over the furnace. The tubes are grouped together into sections and are connected at the top and bottom ends to tube plates in the ends of headers of cylindrical form. The top headers are connected to one another and to a horizontal drum by steam and water tubes or nipples, and in the rear of the drum a section with vertical tubes is placed to act as a heater of, and separator of sediment from the feed-water. The bottom headers are also coupled together by nipples. A modified arrangement with two furnaces is also shown. F. J. R.

669. *Fuel Value of North Dakota Lignites.* **F. A. Wilder.** (Eng. and Mining Journ. 75. pp. 222–223, Feb. 7, 1903.)—The average amount of fixed carbon found in 78 samples, dried before analysis, was 51·5 per cent. Few samples showed as low as 40 per cent. or as high as 60 per cent. On the fixed carbon basis the lignites are equal to 75 per cent. of Pennsylvania bituminous coal, and are on a par with the coals of Iowa, Missouri, and Kansas. The volatile matter in 60 specimens averaged 35·63 per cent., which is higher than in Iowa coal and Eastern bituminous coals. Ash in 60 specimens was 8·5 per cent. Eight samples had less than 5 per cent., 14 less than 6 per cent., 23 less than 7 per cent., and 32 less than 8 per cent. Ten typical specimens analysed for sulphur showed an average of 0·7 per cent., the highest being 1 per cent. Ordinary analyses show 17 to 30 per cent. moisture, but when care is taken to prevent drying in transit to the laboratory 30 to 35 per cent. is the normal amount. Special grates with brick arch projecting above, and hot blast are required to obtain the best heating effects. With these appliances the evaporative power of lignite was found to be 4·1 lbs. of water from and at 212° F., as against 5·44, 5·21, and 6·52 lbs. for Iowa coals, and 6·84, 6·27, 6·28 and 5·86 lbs. for Missouri coals. The lignites have been successfully used in locomotives on the Northern Pacific railroad, a trip having been performed with 18 tons 500 lbs. lignite at $1 per ton, or $18·25, which required 8 tons of Eastern coal at $4·03, or $32·24, realising a money-saving in favour of lignite of 43·4 per cent. F. J. R.

670. *Impurities in Crude Petroleum of Low Gravity.* **P. W. Tompkins.** (Journal of Electricity, S.F. 12. pp. 219–222, Nov., 1902. Paper read before the 10th Annual Meeting of the Pacific Coast Gas Association, S.F., July 15 and 16, 1902.)—This paper gives the results of some experimental variations of the ordinary gasoline test for the determination of sand, water, &c., in natural oils. The California oils contain from 0 to 40 per cent. of asphaltum, which interferes with the accuracy of results. Many of these heavy oils when first pumped from the wells carry from 15 to 35 per cent. land and water, but the majority of this deposits by settling if sufficient time

Digitized by Google

is allowed. The usual test is, 100 c.c. oil mixed with 150 c.c. gasoline, heated for 6 hours at 120° F. and allowed to stand for from 2 to 18 hours, but with oils of from 10° to 20° B. the results are generally too low. The modifications proposed affected the proportion of gasoline to oil employed and the periods of standing, the object being to reduce the error due to precipitation of asphaltum. 800 c.c. of gasoline of 70° B. to 200 c.c. of oil of 15° to 20° B. was found to be a good ratio, but 850 c.c. gasoline to 200 c.c. of oil when oils were below 15° B. The original paper must be consulted for the tabulated results of tests and analyses of impurities. F. J. R.

GAS AND OIL ENGINES.

671. 1,000-*h.p. Gas Engine.* (Engineering, 74. pp. 302, 310, and 312, Sept. 5, 1902.)—The engine was constructed by the Deutz Gas-Motor Works, and exhibited at Düsseldorf. The description is accompanied by three sectional drawings. The engine has four cylinders placed opposite each other, in pairs. The diameter of the cylinder is 33·07 in., length of stroke 41·33 in., and the engine makes 135 r.p.m. Each cylinder works on the four-cycle single-acting principle, and therefore the action of the engine is similar to that of a one-cylinder steam engine. The outside end of each cylinder at the lower part is provided with an exhaust valve, and at the top with an inlet valve. The latter is divided into two spaces by a plate, the top space being connected with the gas supply and the lower one with the air supply. During the suction period the gases are forced several times through narrow vents—thus their mixture is complete. The gas supply is regulated by two spring governors acting on tapered pins. The engine weighs 219 tons, including the 19 ton flywheel. C. C.

672. 500-*h.p. Körting Gas Engine and Blowing Cylinder.* (Engineering, 74. p. 410, Sept. 26, 1902.)—This engine was constructed by the Siegener Actien-Gesellschaft, of Siegen, and exhibited by them at Düsseldorf. There are five sectional drawings shown. The blowing cylinder, which is 69 in. in diameter, is provided with governed Corliss inlet valves and with Riedler-Stumpf delivery valves. These latter are closed at the end of each stroke by rubber buffers fitted to the piston. The engine-piston is about half the length of the cylinder in depth, and the exhaust ports are at the centre of the cylinder length, one set serving for both ends of the cylinder. The engine is provided with two pumps, one for scavenging purposes and the other furnishing the gas. The scavenging blast is followed directly by the charge of air and gas, which is compressed and fired in the usual way. There is thus an impulse every stroke. The governor regulates the supply by opening a bye-pass on the delivery from the gas pump. The compression is 120 lbs. per sq. in., the pressure on firing may attain over 400 lbs. per sq. in., the mean pressure being about 90 lbs. per sq. in. The diameter of the engine cylinder is 26·87 in., and length of stroke 43·31 in. C. C.

673. *Gas-Engine Test.* **R. Mathot.** (Power, N.Y. 28. pp. 64–65, Feb., 1903.)—The author gives the results, with specimen diagrams, of a test of a Charon gas engine at Winterthur. The engine was a 28-b.h.p. Otto cycle, hit-and-miss governing, with electromagnetic ignition. At full load with town gas of 598 B.T.U. per cub. ft. the b.h.p. was 22·9 and the consumption 15·5 cub. ft. as used, corresponding to 13·5 cub. ft. at N.T.P., per b.h.p.-hour. With producer gas obtained from Belgian anthracite, the b.h.p. was 20·2, and the fuel consumption 0·81 lbs. per b.h.p.-hour. H. R. C.

Digitized by Google

AUTOMOBILISM.[1]

674. *A 12-h.p. Spirit Locomobile.* (Engineering, 74. p. 310, Sept. 5, 1902.)—This horse-drawn, portable engine is for driving threshing and other agricultural machines and was exhibited at Düsseldorf. It weighs 4 tons. The length, without shaft for the team, is 11 ft. 2 in.; width, 6 ft. 3 in.; height, 7 ft. 10½ in.; wheelbase, 6 ft. 1 in.; distance between wheels, 4 ft. 7 in.; diameter of front wheels, 2 ft. 7½ in.; diameter of hind wheels, 3 ft. 7½ in.; diameter of driving drum, 23⅝ in.; speed of driving drum, 420 r.p.m.; width available for belting, 7⅛ in. The motor is above the rear axle, and its action is transmitted from one of the flywheels to a counter-shaft placed over the front axle and fitted with two pulleys, from one of which the machine to be worked is driven by belt. The capacity of the spirit reservoir is sufficient for 10 hours' working. C. C.

675. *Auto-benzine Fire Engine.* (Engineering, 74. p. 310, Sept. 5, 1902.)—This was exhibited at Düsseldorf by the Deutz Gas-Motor Works. The motor is a 15-h.p. engine placed over the rear axle. The motor crank-shaft is extended in front, and is provided with friction couplings for working the pump, the arrangement being such that, while travelling, the pump mechanism is disconnected and *vice versâ*. The motor is supplied with benzine by an atomiser, which consists of a receiver in which the benzine is maintained at a constant level by a ball-cock; a second receiver is provided with the rose and the air-pipe. During the suction stroke a current of air passes over the benzine and draws away a portion of it, which gets atomised in its travel. The fire engine has two travelling speeds, viz., 7 and 10 miles an hour. At a speed of 50 revs., the pump delivers 162 gallons per minute at a pressure of 85·3 lbs. to 99·5 lbs. per sq. in. The capacity of the pump tank is 110 gallons. C. C.

REFERENCES.

676. *Economy of Marine Screw Engines.* **E. Hall-Brown.** (Inst. Engin. and Shipbuilders, Trans. 45. pp. 33–56, April; and Discussion, pp. 6–28, Aug., 1902.)

677. *2,000-h.p. Tandem Steam Engine.* (Engineering, 75. pp. 38 and 40, Jan. 9, 1903.)—Drawings and a description of the engine are given. It is a twin tandem compound engine; high-pressure cylinders 28½ in. diameter, low-pressure cylinders 43¼ in. diameter, 51·2 in. stroke; speed 72 r.p.m. Steam pressure 147 lbs. per sq. in. H. R. C.

678. *Balancing of Rolling Mill Engines.* **G. Service.** (Mech. Eng. 11. pp. 213–216, Feb. 14, 1903. Paper read before the West of Scotland Iron and Steel Institute.)—The author examines the crank-effort diagram and the balancing of a two-cylinder and of a three-cylinder rolling mill engine, and states the necessity for having the turning moment applied to the rolls as uniform as possible. In conclusion the author states that the three-cylinder engine is much the more suitable. H. R. C.

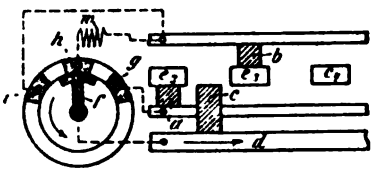
679. *Reducing Valve.* (Mech. Eng. 11. pp. 280–281, Feb. 28, 1903.)—A description with drawings of a combined reducing and safety valve manufactured by Messrs. Royle, of Manchester. H. R. C.

[1] Electric Automobiles are described in the Section dealing with Electric Traction.

Digitized by Google

INDUSTRIAL ELECTRO-CHEMISTRY AND GENERAL ELECTRICAL ENGINEERING.

680. *Non-sparking Accumulator-switch.* **P. Thieme.** (Elektrotechn. Zeitschr. 24. pp. 117–120, Feb. 12, 1908.)—In this switch e_1 e_2 e_3 are the contacts to which the regulating cells are connected; d the contact-bar through which the current passes to the external circuit; c the movable bridge-piece connecting d and e_1 or e_2, &c.; a and b are auxiliary bridge-pieces fixed on the same carriage as c and sliding along separate contact-bars. The carriage bearing the pieces a, b, c, is moved by means of a nut and a spindle having a quick-threaded screw, the parts being arranged so that the piece c moves from one contact e to another during each complete revolution of the spindle. This spindle bears at one end a contact-arm f permanently connected to the bar d and moving over a series of fixed contacts g, h, i, of which g is connected with the contact-bar of the piece a; h to the contact-bar of the piece



b through a resistance w; and i directly to the last-mentioned bar. The resistance w is such that when the full-load current is passed through it, the potential difference across its terminals is equal to that of the cell or group of cells connected between each pair of contacts e_1 e_2, &c. Thus as c moves from one contact e_2 to the next, a and c are first short-circuited before c leaves e_2; then b and c are connected through w, while c is out of contact with e_2 and e_3, and the connection between a and c broken immediately afterwards (see Fig.); b and c are then short-circuited and the connection through w broken immediately afterwards; finally c moves fully on to e_3 and b and c are disconnected. By this means all contacts are broken at the contact-piece f, where the sparks are reduced to a minimum by the arrangements above described. This instrument is made by the Dr. Paul Meyer A. G. and works very satisfactorily in practice. The original paper is very fully illustrated.

C. K. F.

681. *Tangential Water-wheels.* (Engineering, 75. pp. 401–404, March 27, 1908.)—In this article a summary is given of the development of the tangential water-wheel, with special reference to its application in water-power development on the Pacific coast of North America, where they are most suitably employed, the head being generally great and the quantity of water comparatively small. The water supply there is heavily charged with sand, and the erosion of the buckets, although sensibly uniform, is very great. The fact that the bucket can be changed without the renewal of the whole wheel has caused this type of wheel to come much into use there. The article is fully illustrated, showing the different improvements made in the construction of the buckets, and contains some critical remarks in connection therewith;

Digitized by Google

several of the governing devices used are also described in detail, and the results of a few tests made by independent experts, with similar wheels, are also given, but they do not seem to agree, the efficiencies obtained varying from 70 per cent. to over 90 per cent. No details are given as to how they are obtained. Wheels of this type have been supplied by Messrs. Abner Doble & Co., of San Francisco, to the Snoqualmie Falls Power Company. [See Abstract No. 980 (1901).] Several other plants are also mentioned where similar wheels are in successful use. L. G.

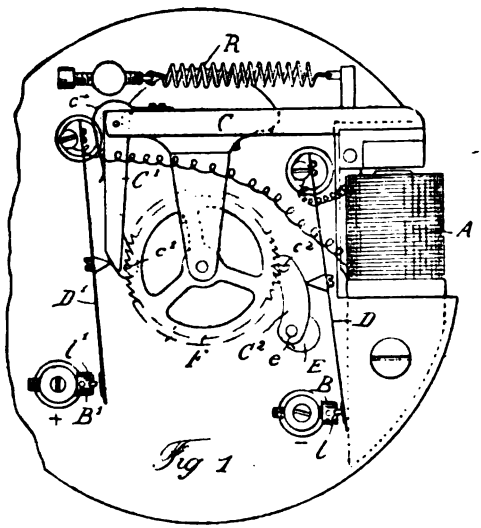
682. *The Woodward Water-wheel Governor.* (Eng. Record, 47. pp. 183–184, Feb. 14, 1903.)—In this article an illustrated and detailed description is given of a friction water-wheel governor, made by the Woodward Governor Company, of Rockford. The governor is fitted with two shafts, one connected to the turbine shaft and the other to the gate-moving mechanism. The cam action used is capable of very close adjustment, enabling the governor to act on very small changes of speed. When the load is steady the governor will not act upon the gate, consequently there is less wear on the mechanism than with governors that keep the gates in continuous motion. The device used to prevent the racing of the governor is fully described in the article. The largest-size governor made is the one described, and has a friction wheel of 24 in. diameter, and 12 in. width, and is made with sufficient surface to transmit, if necessary, 5,000 ft. lbs. per second to the turbine gate. All parts are made interchangeable. Governors of the type described have been in successful use for some time. L. G.

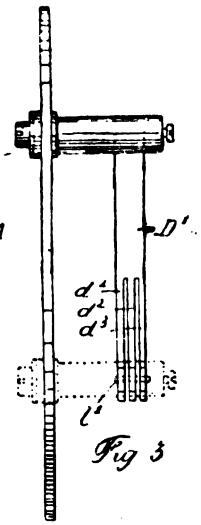
683. *Meters for Unbalanced Three-phase Circuits.* **R. Arnò.** (Elettricità, Milan, 22. pp. 21–25, Jan. 11, and pp. 36–38, Jan. 18, 1903.)—The measurement of power in three-phase circuits by means of two meters depends for its accuracy on the currents in the pressure coils being exactly in phase with the differences of potential in the case of meters of the electro-dynamometer type, and exactly a quarter-phase behind in the case of meters of the more usual rotating field type. In order to fulfil these conditions exactly the author connects the pressure coils as a shunt to part of a suitably arranged choking coil. By adjusting the ratio of the different parts of this the instruments are corrected. To test the accuracy of the adjustment, the connections of the pressure coils of the two meters are interchanged when the meters should register nothing when a non-inductive load, however great, is applied. A further improvement consists in the addition of a small fine-wire coil in each meter placed geometrically parallel with the series winding, but in series with the pressure coil of the *other* meter. As the current in such a coil is in phase with that in the series coil (when the latter has no lag), it serves to create a weak initial field sufficient to compensate for the friction of the meter. [See Abstract No. 577 (1903)]. A. E. L.

684. *Perret's Electric Clock.* **D. Perret.** (Elekt. Runds. 20. pp. 82–84, Jan. 15, 1903.)—In this clock the armature-frame C bearing the feed-pawl C′ is pivotally mounted coaxially with the minute-wheel arbor to which the ratchet-wheel F is fixed. The axis *e* of the retaining pawl is mounted eccentrically on a rotatable support E to enable the position of this pawl to be adjusted. The ends of the electromagnet coil A are respectively connected to contact-springs D, D′, insulated from the clock-frame and actuated respectively by the retaining pawl c^2C^2 and the feed-pawl $c'C'$. When the spring R is tensioned by the magnet A (Fig. 1), the contact D′B′ is broken by

Digitized by Google

the action of the spring D′, and is not remade until the pawl C′ has been moved down again by the spring R, whereupon the inward motion of the retaining pawl allows the contact D B to be made by the action of the spring D, and the circuit to be completed afresh. Each spring is divided at the end into three, d', d^2, d^3 (Fig. 8), each end forming a separate contact arranged so as to act successively against the respective fixed contact, and thus ensure that the





sparking shall only take place on one of them. In order to reduce friction, the spring c is made weak, the pin c' round, and the pin c^2 half-round. As the fixed contacts B, B′ are both insulated from the clock-frame, no current passes through the pivots or other working parts. The clock is actuated by one or two dry cells, which act for 1/800th second per minute. The minute-wheel is connected through the usual train with an escapement and balance-wheel.

C. K. F

REFERENCE.

685. *Tommasi Accumulator.* **D. Tommasi.** (Comptes Rendus, 135. pp. 1328–1329, Dec. 29, 1902.) [See also Abstract No. 626 (1903).]

Digitized by Google

GENERATORS, MOTORS, AND TRANSFORMERS.

686. *Electrical Resistance of Bearings.* **A. E. Kennelly** and **C. A. Adams.** (Elect. World and Engineer, 41. p. 231, Feb. 7, 1903.)—The oil in the bearing may cause a shaft to be insulated from the machine. The authors tested a small machine, running at 1,800 r.p.m. When at rest the shaft was in good electrical contact with the bearing; at a speed of 100 r.p.m., however, the resistance between the shaft and the pedestals was 4·4 megohms, which amounted to 1,000 megohms per sq. cm. of oil surface. The insulation is maintained under very considerable lateral pressure. With new dynamos, where the bearings are not worn, the insulation resistance is much smaller in amount. The insulation resistance in the case examined did not break down under 500 volts direct current or 1,670 alternating; but in the latter case it was very much reduced. W. H. S.

687. *A Rotary Synchroniser.* (Electrician, 50. p. 422, Jan. 2, 1903.)—This is a description of an instrument made by Everett, Edgcumbe, & Co., which consists of a small two-phase motor, the rotor of which is mounted on ball-bearings and carries a pointer. The rotor is connected to the incoming machine and the stator to the bus-bars; two rotary fields are thus produced, and when these are of the same frequency the rotor is at rest; when the frequencies differ the pointer indicates, by its motion in one direction or the other, whether the incoming machine is too fast or too slow. By a simple arrangement, which is described, a green or a red lamp is exposed according to the direction in which the rotor moves. A diagram of connections is given, and an illustration of the synchroniser dial. B. P. S.

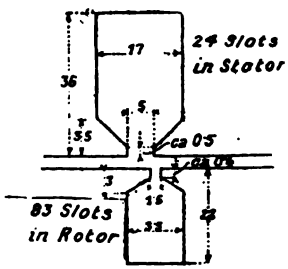
688. *Single-phase Alternating-Current Series Motors.* **P. Girault.** (Ind. Élect. 12. pp. 81–84, Jan. 25, 1903.)—A theory of the working of a bi-polar alternating-current series motor with a ring-wound armature is given. Simple formulæ for the current, torque, &c., are obtained in terms of the reluctance, number of windings, resistance and speed of the armature, the number of windings of the field magnets, and the frequency of the supply. The brushes are supposed placed so that the line joining them is perpendicular to the field flux. By making the frequency zero in the formulæ, the ordinary equations for a direct-current series motor are got. Equations are also obtained for the case when the line joining the brushes makes any angle with the field flux. A. R.

689. *Wattless Current of Synchronous Motor.* **E. Rosenberg.** (Elektrotechn. Zeitschr. 24. pp. 111–114, Feb. 12, 1903.)—When the p.d. and current waves in an alternating-current circuit are of different form, the power-factor can never become unity. In the case of two alternators of different wave-form, one of which is being driven as a synchronous motor by the other, the highest power-factor obtainable by varying the excitation of the motor may still fall considerably below unity. The author mentions a case in which the highest power-factor was only 0·86. This effect is most noticeable with motors running light. The following graphical method of representing the various components of the current is suggested by the author. Taking three

Digitized by Google

rectangular co-ordinate axes in space, let a vector drawn in the direction of the x-axis represent the p.d. across the motor terminals; another vector, along the same axis, may be taken to represent the power component of the current. A vector is next drawn along the y-axis to represent that wattless component of the current whose frequency is the fundamental frequency. The wattless components of higher order are then represented by a vector drawn along the z-axis, while the resultant of the x, y, and z current vectors gives the total current. The ratio of the watts to the volt-amperes is given by the cosine of the angle made by the resultant current vector with the x-axis or p.d. vector. The author gives examples of the application of this method to the study of the behaviour of three-phase generators and shows how the relative importance of the third and fifth harmonics in the wave-form may be estimated by suitable measurements. A. H.

690. *Air-gaps of Induction Motors.* **M. Breslauer.** (Zeitschr. Elektrotechn., Wien, 21. pp. 83–86, Jan. 18, 1903.)—One of the most serious outstanding objections to induction motors lies in the necessity for working with an air-gap so small as to present serious mechanical difficulties, even though these, by careful design and construction, are successfully overcome



in practice. The author has made experiments to ascertain how far an increase of the air-gap is admissible without unduly increasing the lag. The following are the dimensions of the four-pole motor used for the experiments: Outside diameter of stator, 420 mm.; inside, 240 mm.; length, 110 mm. Beginning with an air-gap of 0·5 mm. (measured radially), the rotor was slightly turned down three times, and the magnetising and short-circuit current read for each diameter with the following results :—

Air-gap.	Magnetising Current. i_m.	Short-circuited Current.		$\tau = \frac{i_m}{i_{ok}}$
		Reading i_k.	Corrected i_{ok}.	
0·5	4·0	54	56	0·0715
0·65	4·5	68	66·5	0·0680
0·8	5·2	64·5	68	0·0770
0·9	5·9	66·5	71	0·0830

It will be noticed that the ratio τ between magnetising current and short-circuit current actually decreases on increasing the air-gap to 0·65 mm. This may be explained by the form of the slots shown on the accompanying sketch. The first increase in air-gap would make the most difference in the magnetic leakage over the narrow openings of the slots. A. E. L.

Digitized by Google

691. *Tandem Coupling of Induction Motors.* **M. Breslauer.** (Elektrotechn. Zeitschr. 24. pp. 1–6, Jan. 1, 1903.)—Two induction motors are said to be coupled in tandem when the rotor of the first motor supplies current to the stator of the second, whose rotor is, as usual, short-circuited at full load. The object of this arrangement is to reduce the speed of the mechanically coupled motors to half that of synchronism. The author applies Heyland's and Blondel's methods to the problem of two motors so coupled. The torques exerted by the motors are equal under all conditions of load. If the motors are coupled direct, their common speed will be about half that of synchronism. But if the mechanical coupling consists of gearing so arranged that the second motor runs at half the speed of the first, the first will run at one-third the speed of synchronism. Various other arrangements are obtainable by suitably arranging the velocity ratio of the motors. In the case of a tramcar, the gearing may be different for each motor, and if chosen so as to give a velocity ratio of 10 : 4 for the two motors, the following four possible speeds are obtainable: Motor I. alone, 100; motors I. and II. coupled in opposition, 66·7; motor II. alone, 40; motors I. and II. tandem, 28·5. This arrangement, so far as the results are concerned, is equivalent to that proposed by Danielson [see Abstract No. 1796 (1902)], who, however, employs a totally different method. In spite of its seeming advantages, however, the author considers the method as practically useless on account of the extremely low power-factor and poor overload capacity possessed by the motor combination. Such a combination has a short-circuit or stand-still current, not more than about 1·5 times that of a single motor, but a no-load current which is about double that of a single motor. The overload capacity of the combination is only half that of a single motor, or only quarter that of the two motors when run independently. The author suggests that a suitable phase compensator might render the arrangement more practicable. A. H.

692. *Separation of Losses in Induction Motors.* **O. S. Bragstad** and **J. L. la Cour.** (Elektrotechn. Zeitschr. 24. pp. 34–35, Jan. 8, 1903.)—The moment of inertia of the rotor is determined by equating the expression for the power $I\omega d\omega/dt$ obtained from the retardation curve (the motor having been run up to a suitable speed, and then allowed to come to rest under the retarding effect of frictional forces alone, readings of ω (angular velocity) and t (time) being taken as it slows down) to the power which must be electrically supplied to the stator in order to keep the motor running at the same speed, the rotor being supplied, through its slip-rings, with a weak exciting current, so as to run synchronously, and the stator p.d. being adjusted so as to yield the minimum power-factor. The moment of inertia being known, the retardation curve just referred to enables the friction losses at various speeds to be calculated. The total losses at various speeds, but constant maximum field, are next determined by allowing the motor to run light, the generator being excited with a constant current but run at varying speeds. By subtracting the ordinates of the frictional loss curve from those of the total loss curve, the iron losses are obtained. These may be separated into hysteresis and eddy losses in the usual way. The authors conclude by adversely criticising Benischke's method [see Abstract No. 2277 (1901)]. A. H.

693. *Best Thickness of Transformer Stampings.* **H. Kamps.** (Elektrotechn. Zeitschr. 24. pp. 93–95, Feb. 5, 1903.)—On account of the appreciable thickness of the insulation between the stampings, the total iron loss, for a given total magnetic flux and total cross-section of core, does not decrease in-

Digitized by Google

definitely as the thickness of the stampings is decreased, because, although the eddy-current loss decreases steadily, the hysteresis loss increases on account of the increasing induction due to the reduced cross-section of iron. The author deduces the following formula for the best thickness t of the stampings: $t = 79\sqrt[3]{\frac{\eta\delta}{n B_i^{0.4}}}$, where η is Steinmetz's hysteretic coefficient, δ = thickness of insulation between stampings, n = frequency, and B_i is the ideal induction obtained by dividing the flux by the total cross-section of the core (no allowance being made for insulation). Assuming as average values $\eta = 0{\cdot}0015$, and $\delta = 0{\cdot}05$ mm., the author arrives at the following table of values of t:—

Frequency n =	25	50	50	100	100	140
Ideal Induction B_i =	8,500	5,000	4,000	3,500	2,500	1,500
Actual Induction B =	10,000	6,000	5,000	4,000	3,000	2,000
Best thickness t =	0·34	0·29	0·30	0·24	0·25	0·24

Taking next the special conditions relating to Continental practice, the author also finds that the values oscillate about 0·3 mm., and he accordingly suggests that this should be adopted as the standard thickness for transformer sheets. A. H.

694. *Graphical Method of Predetermining Regulation of Unequally Loaded Three-Phase Transformer.* **A. König.** (Elektrotechn. Zeitschr. 24. pp. 21–26, Jan. 8, 1903.)—The author assumes a star coupling for both the secondary of the transformer and the load. Assuming that the e.m.f.'s of the three phases, the currents, resistances, and power-factors are given, he shows how to obtain the p.d.'s (1) for a non-inductive load; (2) for an inductive one. Various special cases are considered in detail, and a numerical example worked out by way of illustration. The author compares his method with that given at an earlier date by F. Blanc [see Abstract No. 158 (1901)], and claims the merit of simplicity for it, although the results obtained by the two methods are identical. A. H.

695. *The Nodon Electric Valve.* (Electrical Times, 22. pp. 791–792, Nov. 27, 1902.)—For use with single-phase current the valve consists of four cells connected in the usual manner. Each cell consists of an iron cylinder with a hole at its lower end fitted with an insulating plug. Through the plug passes a cylinder of zinc and aluminium alloy, concentric with the iron tube, and provided with a terminal at the lower end. The electrolyte is a saturated solution of ammonium phosphate. For polyphase work there must be a pair of cells for each distributing wire. Pressures of 50 to 140 volts per cell may be employed, and two or more cells may be used in series. Adjustable insulating sleeves placed over the cylinders of alloy enable the efficiency to be kept constantly at from 75 to 80 per cent. with varying loads. The larger valves are fan-cooled. [See also Abstracts Nos. 2281 and 2282 (1901).]
G. W. DE T.

REFERENCE.

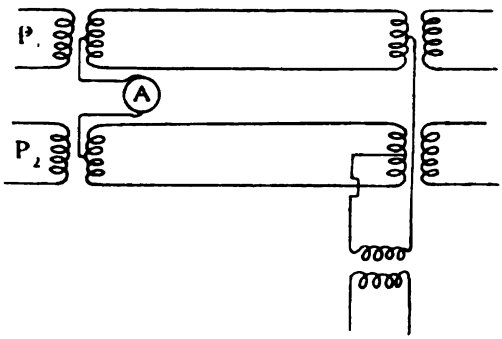
696. *Novelties in Electrical Machinery.* **J. Löwy.** (Zeitschr. Elektrotechn., Wien, 21. pp. 49–53, Jan. 25, and pp. 67–70, Feb. 1, 1903.)—The article contains a valuable summary of novel methods in the construction of electrical machinery introduced during the year 1902. G. W. DE T.

Digitized by Google

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

697. *Bedell System of Composite Transmission.* **A. S. McAllister.** (Elect. World and Engineer, 41. pp. 851–858, Feb. 28, 1903.)—This method of transmitting power is based on the independence of two alternating currents of different frequency, or of an alternating and a continuous current, when flowing along the same conductor. In the Bedell system a high-frequency single-phase or a continuous current is superposed on a low-frequency two-phase system. The general principle of the arrangement will be readily understood from the accompanying sketch, in which P_1, P_2 are the primaries of a two-phase step-up transformer, connected to a two-phase generator of



low frequency, intended for the supply of power to motors. Connected to the middle points of the secondary windings is a high-frequency single-phase alternator or transformer A, which is intended for lighting circuits. Similar connections are adopted at the receiving end of the line. It is obvious that a continuous current might be used instead of the high-frequency single-phase one without in any way interfering with the two-phase system. Assuming that the total loss in the line and the amount of copper and line voltage are the same, the Bedell system is capable of transmitting 1½ times the power which a simple three-phase system could transmit. It has further the great advantage of independent regulation of pressures. [See also Abstract No. 366 (1903).] A. H.

698. *Five-Phase System.* **E. W. Ehnert.** (Zeitschr. Elektrotechn., Wien, 21. pp. 89–94, Feb. 15, 1903.)—This is a theoretical investigation of the properties of a five-phase system; the author shows how the self-inductance and capacity of a five-wire five-phase transmission line may be calculated. A numerical example on power transmission is worked out with (*a*) a three-phase and (*b*) a five-phase system of transmission. For a given line voltage the five-phase system requires only about half the copper corresponding to the three-phase system, and the voltage drops along the line are less. The author suggests that possibly the five-phase system might be advantageous for exceptionally large schemes of power transmission. A. H.

Digitized by Google

699. *Automatic Voltage Regulation.* **H. C. Wirt.** (West. Electn. 32. p. 90; Discussion, pp. 90–91, Jan. 31, 1903. Paper read before the North-Western Electrical Association at Milwaukee, Wisconsin, Jan. 22, 1903.)—This paper describes a regulator which has been invented by A. A. Tyrell, and is being manufactured by the General Electric Company of America. The general principle of the device is to short-circuit a resistance in series with the field of the generator, and immediately after this operation to replace the resistance by removing the short-circuit, the voltage therefore depending on the length of time the resistance is in circuit. This cycle of operations is made at a high rate of speed, varying from 50 to 800 times a minute, the resistance being switched in and out by means of a relay. The relay contacts, which are connected to the terminals of the field rheostat, have a motion of about $\frac{1}{16}$th of an inch, and a condenser is connected to these contacts to prevent sparking. The relay is controlled by a magnet, which is connected by pressure wires to the centre of distribution. With an alternate-current generator the regulator varies the resistance in series with the field of the exciter. Diagrams are given showing the connections and outlines of construction in the case of a voltage regulator for an alternate-current circuit. Devices are also described for keeping the voltage constant at the further end of an alternate-current feeder. In one of these a booster transformer is used, similar to the constant-current transformer used with series arc lamps, the movement of the coils being effected by compressed air and controlled by a voltmeter. In cases where a transformer is used to supply a feeder a switch can be used to vary the number of effective turns on the secondary; a motor turns the switch round on its dial, and the controlling voltmeter operates magnetic clutches which connect the motor to the switch. It is said that no flickering is noticeable in the light, provided the rapidity of the relay magnet is sufficiently great. W. H. S.

700. *Modern Tendencies in the Development and Transmission of Power.* **J. J. Flather.** (Eng. News, 49. pp. 5–7, Jan. 1, 1903. Address delivered before the A.A.A.S., Dec. 29, 1902.)—The author states that, in two cases which he investigated, the losses in shafting amounted to 80 and 98 per cent. respectively. The average loss is probably between 40 and 50 per cent. The flexibility of an electrical system is its great recommendation; but it by no means follows that, even in the generality of cases, it is more economical than a well-designed steam system with suitably arranged shafting. For varying the speed of motors, a multiple voltage system has advantages, but it cannot be used with an outside source of power without rotary transformers, and it is, moreover, complicated and expensive. A three-wire 220-volt system is a simple example. Another method involves the use of a three-wire generator with collector rings connected to the armature winding, similar to that of a two-phase rotary converter. Balancing coils are used, and the middle points of these are connected to the third wire, which is thus maintained at a voltage half-way between those of the outer wires. With alternate-current induction motors the speed may be varied by rheostatic control; or by varying the impressed voltage by means of a variable-ratio transformer, which is a very inefficient method at low speeds; or by altering the number of poles, which is complicated, but may be used efficiently if the speed is to be reduced to one-half or one-quarter of its normal amount. At the Baldwin Locomotive Works it was found that with motors aggregating 200 h.p. a generator of 75 kw. was sufficient; ordinarily the total load amounted to 60 kw., or about 40 per cent. of the total power installed. This is due not only to intermittent

Digitized by Google

running of motors, but also to the fact that the motors are seldom worked at their full rated capacity. In numerous tests made by the author, he has found the average load on several motors to be only one-third of their rated capacity. The competition of gas engines will probably be serious in the future, especially in cases where producer gas is used. The discovery that blast-furnace gases can be utilised in the combustion engine without the use of boilers or any purifying processes is of great importance, and Hubert of Liège has shown that, owing to the superior economy of the gas engine, equal power can be obtained with 20 per cent. less consumption of furnace gas than was formerly used in the generation of steam. The best thermal efficiency which has yet been recorded for a gas engine was 38 per cent., and was obtained by Meyer of Göttingen with a two-cycle engine, which compresses the air and gas in separate pumps to a nominal pressure of 8 or 10 lbs., the air under this pressure being used to scavenge the cylinder towards the end of the expansion. After the unconsumed products of combustion have been forced out by the fresh air, a charge of gas is admitted and compressed to 150 lbs., and then exploded. The engine is complicated in its details, and it remains to be seen whether it will work out satisfactorily in small sizes. W. H. S.

701. *Steam* v. *Water Power for Electricity Works.* **A. Hecker.** (Elektrotechn. Zeitschr. 24. p. 131, Feb. 19, 1903.)—The author has recently had under his notice a scheme for developing and utilising water power by means of a dam erected across a valley, which would have involved a capital expenditure of M1,500,000 (£75,000) for the production of only 600 h.p. He has therefore calculated what conditions of load would be required to render such a source of supply cheaper than steam power, assuming that coal would cost 2 pfg. per kg. (20s. per ton) at the point of use, and that no running charges would be incurred when the water-power scheme had once been successfully inaugurated. He calculates that a capital expenditure of M400,000 (£20,000) would provide a steam plant to produce 600 h.p., and taking interest at 4 per cent., and other capital charges, including depreciation, at between 4½ and 8½ per cent., he obtains the following comparative costs :—

	Steam Power.				Water Power.			
H.P.-hrs. per year.	1,200,000	1,800,000	2,400,000	3,600,000	1,200,000	1,800,000	2,400,000	3,600,000
Cost per h.p.-year in Marks	93·70	112·61	131·48	169·22	127·50	127·50	127·50	127·50

The water-power plant would therefore only prove more profitable than a steam-power plant where a load-factor of 60 per cent. or over could be obtained. J. B. C. K.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

702. *Electric Power at Manchester Cotton Mills, N.H.* (Elect. World and Engineer, 41. pp. 269–271, Feb. 14, 1903.)—Most of the power and lighting is carried out by polyphase current. The printing presses for the cotton prints are, however, driven by direct-current motors, each of them being supplied with current from a separate dynamo. The excitation of the magnets of the motors is kept constant, but the operator has the power of varying the excitation of his dynamo by means of a rheostat having fifty-one steps, the dynamos

Digitized by Google

themselves being driven by induction motors. The speed of the printing-press motors can therefore be varied from 1¼ to 19 r.p.m. by shifting the handle of the controlling rheostat over the fifty-one steps, each step increasing the speed on an average by about one-third of a revolution, and the voltage at the terminals of the motor armature is found to vary from 26 to 315.

W. H. S.

703. *Mill Creek Power Plant, Redlands, Cal.* **E. Duryee.** (Eng. News, 49. pp. 133–134, Feb. 5, 1903.)—This installation is one of several owned by the Edison Electric Co. of Los Angeles, and is situated 12 miles from Redlands. Water is derived from the Mill Creek Cañon, 5 miles from the power-station, through a tunnel and short flume, fitted with a travelling screen to remove twigs, and sand-settling boxes. From the flume a pipe line takes the water 25,000 ft. to a forebay; the pipes are of cement, in sections 2 ft. long and 30 in. in diameter, made near the site of the line, and laid with a gradient of 0·2 per cent. This line passes through nineteen tunnels, aggregating 7,490 ft. in length, and includes five inverted siphons to cross cañons. The forebay stores sufficient water to carry the peak load for six hours. The pressure pipe line starts from the forebay, is 8,400 ft. long, and has a fall of 1,906 ft. The lower pipes are 24 in. in diameter, and ⅜ to ⅞ in. in thickness. The power station is of concrete, with corrugated iron roofing, and forms an extension to a previously existing station, which contains two Pelton wheels coupled to 300-h.p. three-phase alternators working at 11,000 volts. The new plant comprises four sets of 1,200 h.p. each, working at 33,000 volts. A. H. A.

704. *New Power-Stations at Newport, R.I.* (Street Rly. Rev. 13. pp. 77–80, Feb., 1903.)—The Massachusetts Electric Companies have decided to adopt Curtis steam turbines for the four new power-houses which are to supersede the existing fourteen power-houses. They have contracted with the General Electric Company for the supply of ten 3,000-h.p. and three 1,000-h.p. turbines. The latter are in the new station at Newport, the only one yet completed. The plant comprises four 350-h.p. Aultman and Taylor water-tube boilers, with Green economiser and separately fired superheater. The turbines have vertical shafts, and are directly connected to 500-kw. three-phase alternators, running at 1,800 r.p.m. Each is 7 ft. 8 in. in diameter at the base and 12 ft. 6¾ in. high, including the alternator. The 3,000-h.p. turbines for the other stations will run at 750 r.p.m. They will be 12 ft. in diameter and 19 ft. high, and will weigh 85 tons each. A. E. L.

705. *Electric Power Transmission in North California.* (Journal of Electricity, S.F. 12. pp. 231–238, Dec., 1902.)—The generating station of the Northern California Power Co. is at Volta, 30 miles from Redding, and is operated by water-power derived from springs, giving constant flow throughout the year. The water is brought 3,400 ft. in an open canal to a reservoir, capable of running the plant for six hours. From this point the water is carried through pipes for 6,800 ft., most of the pipe being of steel, ⅜ in. thick at the lower end, to withstand the head of 1,204 ft. A separate pipe brings water to the station with a head of 400 ft. to work the auxiliaries. The generating plant consists of three 1,500-h.p. Pelton wheels, coupled to 750-kw. three-phase Westinghouse alternators, all of which generate current at 500 volts. The nozzles of the water-wheels are controlled by Lombard governors. The main shafts are 9 in. in diameter and 10 ft. long, and are carried on self-aligning bearings in

Digitized by Google

large cast-iron bed-plates. The exciters are 21½-kw. dynamos driven by small Pelton wheels mounted direct on their shafts. The transformer-room contains ten 350-kw. transformers, connected in groups of three delta fashion, with one spare; these raise the pressure to 22,000 volts on the line, but if necessary in future they can be joined up star-fashion to give a higher line pressure. The line consists of two three-phase circuits of No. 4 B. & S. bare copper, and runs to Redding, with branches to various places, the longest being 90 miles in length. Glass insulators are used, on wooden poles. At the substations the pressure is reduced to 2,000 volts, three-phase or two-phase, for power and lighting service. The water power available can easily be increased to treble the present capacity at Volta. A 4,000-h.p. plant is being installed at Cow Creek, 20 miles from Volta, consisting of two 1,500-kw. Westinghouse generators coupled to two pairs of Pelton wheels. The plant will be generally similar to the former, working with practically the same head. The exciters will be driven by induction motors and Pelton wheels alternatively. The transmission lines will join the existing lines at two widely separated points. The illustrations accompanying the article relate to the hydraulic works only.

A. H. A.

706. *Some Recent Water Turbine Power Plants.* **A. Steiger.** (Mech. Eng. 11. pp. 359–362, March 14, and pp. 391–394, March 21, 1908. Paper read before the Civil and Mechanical Engineers' Society, Feb. 5, 1908.)—In this paper the author describes the characteristic features of some of the recently erected water-power plants here and abroad. The progress made during the last twenty years is very great. Turbines are now made of units ranging up to 10,000 h.p., as will be the case with the turbines to be erected on the Canadian side of Niagara Falls. There is a scheme in hand to erect turbines to develope 1,400 h.p. under a fall of only 10 ft. The author had to deal in this country with very irregular water supplies, affecting the fall considerably, but got successful results using the double-crowned Jonval turbines. To secure a good efficiency with the minimum supply, and to obtain a constant speed under varying falls, the subdivision of the parallel flow turbines into several compartments of different diameters was used. The quick acting of the governor, which is an essential condition in electric generating plants, has been achieved by the introduction of the hydraulic governor fully described in the paper. The author describes several plants where turbines of the inward flow type are used, like those at Schafhausen; or at Sligo, on a tidal river, where the fall varied from 8 ft. 6 in. to 6 ft. 6 in. at neap tide, and 8 ft. at spring tide. Mention is also made of the new turbines now erected at the new power-house at Niagara Falls, each being of 5,500 h.p. The action of the hydraulic governor invented by Messrs. Escher, Wyss & Co. is shown on a diagram taken under actual operation, and the speed did not vary more than 3½ per cent., whether the load was suddenly increased or reduced, or entirely thrown off, and no "hunting" could be observed. The largest water-power plant in the British dominion is that erected at Cauveri Falls [see Abstract No. 97 (1908)]. The type of turbines used at the Lyons Electric Light and Power-generating Station combines the advantages of the parallel flow turbines with that of greater speed and better efficiency obtained from radial flow wheels, and is therefore suitable for low falls on large rivers. Several other plants are mentioned. The author draws the conclusion that turbines can be made to give satisfactory results if the conditions under which they act are taken into proper consideration, and the right type accordingly selected. The low falls found in all parts of this country ought not to be

Digitized by Google

overlooked as probable sources of power. The author concludes his paper advocating a proper regulation of the water supplies, by building dams, which should retain part of the water coming from the hills, prevent to some extent the floods, which do a great deal of damage to low-lying country, and thereby secure a more regular flow of water for power purposes. The paper is fully illustrated. L. G.

707. *Limmat Valley Street Railway.* **C. S. R. Preller.** (Inst. Civil Engin., Proc. 151. pp. 8–9, 1902.)—This line, 7¼ miles long, connects the town of Zurich with five villages. The curves and also the gradients are easy: the sharpest of the former are two curves of 82 ft. radius, whilst the steepest gradient is about 1 in 18, on a short section of 275 yds. in length. The railway is constructed as a single line, with eight passing-places, each 55 yds. in length, spaced about 1 mile apart. The gauge, like that of the Zurich tramway system, is 1 m. The permanent way is composed of steel rails of Vignoles section, weighing 40¼ lbs. per yd., resting on iron sleepers 5 ft. 8 in. in length, and each weighing 22 lbs., there being fourteen sleepers to each rail-length of 39 ft. 7 in. The bearing capacity between the points of support is therefore 8 tons, while the actual maximum load per wheel is only 3 tons. The permanent way rests on packing and ballast, 6 ft. 6 in. in width and 1 ft. 4 in. in depth, the width of formation outside the public road being 11 ft. 6 in. In the passing-places the permanent way consists of Phœnix girder-rails and turnouts weighing 188 lbs. per yd., and on all road-crossings, sharp curves, and bridges double Vignoles rails are laid. Stops occur about every 330 yds., so that there are about forty in all. The single contact-line, $\frac{5}{16}$-in. in diameter, is elastically suspended at a height of 21 ft. 4 in. above the rail-level from steel brackets, varying in length up to 10 ft. 10 in., which are fixed to wooden poles. The latter are spaced 27 ft. 6 in. to 33 ft. apart, are 10 in. in mean thickness, and 29 ft. 6 in. in height, of which 5 ft. 3 in. is underground and embedded in concrete. The return circuit also consists of a $\frac{5}{16}$-in. copper conductor, and is connected every four rail-lengths with the Chicago bonds of the rail-joints. On the branch line this special return conductor is dispensed with, the electrical bonding being strengthened instead, and the fish-joints and bonds soldered to the rails with a highly conducting amalgam. The poles carry, besides the steel brackets, a $\frac{5}{16}$-in. feeder, and a double service telephone line, which is connected to all the principal stations and stopping-places along the railway, and to the power-station. The line is divided, electrically, into five separate sections, each of about 1¼ miles in length, by special cut-outs, and special cut-out appliances are also provided at the level crossings of the North-Eastern Railway, where the current is switched on only at fixed intervals, when the trunk line is signalled clear, and the electric railway cars can pass. The power-station is at Schlieren, nearly equidistant from the three terminal points. The engine-room contains, at present, two sets of 100-kw. motor generators, built by Brown, Boveri & Co., with space for a third set. Each set is composed of a three-phase, 2,000-volt, 50 ∿ motor, driving on the same shaft a continuous-current 550-volt to 600-volt four-pole dynamo, and making 500 r.p.m. The motors are connected by their own switchboard with the high-tension transmission leading to the Zurich Corporation central station, while the generators are similarly connected with the five sections of the line. To the three-phase transmission is also connected a 3-kw. transformer, transforming down from 2,000 volts to 200 volts, for lighting and day repair-work. The high-pressure transmission from the Zurich central station to the power-station of the railway at Schlieren

Digitized by Google

is about 8¾ miles in length, and is composed of three ¼-in. conductors, which, within the town boundary, are laid underground, and for the remainder are carried overhead on wooden poles about 55 yds. apart, except at the overhead crossing of the North-Eastern Railway, where the unprotected high-tension conductors are passed on both sides over iron towers. At the central station the transmission-line is connected to the 1,000-h.p., 2,000-volt, 50 ∿, three-phase steam alternators, which also feed the motor-generator station of the Corporation Tramways. Peckham car frames are employed, and each passenger motor car, carrying 86 passengers, is equipped with two 25-h.p. 500-volt direct current B.T.H. single-reduction motors. The total cost of construction, including interest during construction, and £1,000 for placing underground, or removing to a distance, overhead telephone and other lines, as required by the Federal Government, was £52,000, or £6,933 per mile. The average losses in the high-pressure transmission and in the motor-generators being 25 per cent., in the continuous-current line 10 per cent., and in motors and gearing 20 per cent.; the total efficiency of the system is $0{\cdot}75 \times 0{\cdot}90 \times 0{\cdot}80 = 54$ per cent. at the car-axles, and 75 per cent. at the continuous-current dynamos. The cost of the three-phase current is 1d. per kw.-hour delivered at the three-phase motors, equal to 1·84d. per kw.-hour of continuous current. Including depôt lighting, and the running motor of the repair-shop, the total cost of three-phase current amounts to 1·05d. per car-mile. The total cost of working is 4·10d. per car-mile. It is proposed shortly to obtain the power, by means of a 2,000-volt transmission line, from a 10,000-h.p. station 25 miles away, and which utilises water power from the river Aare near its confluence with the Rhine. The result of this will be to reduce the present cost of primary three-phase current from 1d. to ½d. per unit. G. W. DE T.

708. *Columbia Electric Tramways.* (Street Rly. Rev. 18. pp. 61–65, Feb., 1908.)—The tramways comprise 14 miles of single track, operated on the overhead trolley system, with bracket and span suspension. The track is laid with 48-lb. T-rails, joined electrically with Columbia bonds. Power is derived from the generating station of the Olympia Cotton Mills, which contains three McIntosh & Seymour engines coupled to General Electric three-phase alternators. The engines are rated at 1,600–2,000 h.p. each, and are of the vertical compound type, with cylinders 20 and 48 in. in diameter and stroke 42 in. The alternators have an output of 1,300 kw. each, at 40 cycles per second, 600 volts, 138 r.p.m. The switchboard is over 57 ft. long, with 21 panels. The pressure is raised by transformers to 3,300 volts and transmitted 2 miles, by six No. 2 wires, to a substation near the centre of the city. From this point power is supplied for various purposes and in various ways: for traction the current is transformed and passed through rotary converters giving direct current at 550 volts. Each of the two converters is rated at 200 kw. For constant pressure light and power, the three-phase current is split into two single-phase currents at the full voltage, and transformed down where it is used, or three-phase current is supplied and transformed to 550 volts for motors over 1 h.p. For series arc lighting, 4 Brush arc dynamos are used, driven by synchronous motors and giving 5 amperes at 10,000 volts each. About 230 arcs and 11,000 incandescent lamps are in use. There are 30 cars of various types, fitted with "G.E. 1,000" motors. Details are given as to the mode of operating the system. A. H. A.

Digitized by Google

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

709. *Electric Tramways.* **C. Hopkinson, B. Hopkinson,** and **E. Talbot.** (Inst. Civil Engin., Proc. 151. pp. 8–48; Discussion, pp. 49–104, 1902.)—This is a paper dealing with various points in the construction and operation of electric tramways, and is based on the experience of the authors in connection with those at Leeds and Newcastle. Some interesting examples are given of the smoothing out of the power consumption curves with a large number of cars on the system. In the case of such systems it is not necessary to design the engines specially for dealing with the large fluctuations which occur with a small number of cars. Nor, in such cases, are storage batteries advantageous for taking charge of the fluctuations. In a system like the Central London Railway, substation storage batteries would be economical, as, although there is a large power consumption, the number of separate trains is small, and there would never be more than six on any one substation simultaneously. Where storage batteries are used, it is worth while to avoid over-compounding, and to connect the batteries across the bus-bars in parallel with the generators. Automatic boosting is advantageous on systems with not more than 70 cars, but unnecessary on larger ones. If a short occurs on the main circuit, then all section-switches should be opened, and the sections restarted singly. Experiments made by one of the authors gave about 0·05 sec. as the time of opening of a circuit-breaker of a well-known type. During this period the load may be three or more times the normal. This produces, between the flywheel and the armature, too large a torque for a shaft of the ordinary size. Hence, modern practice is to bring these as close as possible, and to bolt them together at a considerable distance, radially, from the main shaft. Owing to the force exerted under such conditions on the armature conductors, slot-winding is preferable to surface-winding. The main object of a heavy flywheel is to prevent racing after the circuit-breakers have acted. The requirement often specified, that the maximum speed variation between full and no load should not exceed 2 per cent., is unnecessarily close for continuous-current work, and is probably never realised in practice. The authors have found a variation of 3 per cent. on each side of the mean quite unobjectionable at Newcastle. If the design of the machinery allows for a safe excess of 20 per cent. in speed, then they consider it quite sufficient that the flywheel and governor combined should limit it to a maximum of 10 per cent. A safety steam cut-off is advocated on a rise of 12 to 15 per cent. This should be used nightly in shutting down, so as to ensure its being in working order when required. The most severe requirement of a continuous-current traction dynamo is to withstand a short-circuit without flashing round the commutator. With a fixed brush-lead the authors contend that this compels the use of low-speed multipolar dynamos, and that if high-speed engines are used, devices must be employed to automatically vary the lead. The arrangement of section insulators and feeders is discussed, with illustrations taken from the Leeds and Newcastle systems. If the sections nowhere exceed 2 miles in length, and there is a feed-point near the centre, 10 cars per double mile can be efficiently and economically worked, without any danger of unduly heating the trolley wires, even if all the 10 cars are started simultaneously. Methods of dealing with portions of the line which may be congested during

[1] Non-electrical Automobiles are described in the Section dealing with Steam and Gas Engines.

Digitized by Google

certain periods are given, with the authors' reasons, in the instances cited, for adopting continuous current throughout. Alternative estimates made for this purpose in the case of the Leeds tramways are given. They consider the Leeds system as large a one as can be satisfactorily dealt with by means of a single continuous-current generating station. For larger systems they prefer, where suitable sites are available, several continuous-current generating stations to a single alternating-current generating station with substation converters. Various curves and figures are given dealing with motor performance, more especially in reference to acceleration. To minimise the chance of accidents, the authors advocate a maximum speed uphill, and and a minimum downhill, and they would provide motors capable of a speed of 12 miles per hour on the most severe up-grades. Since the resistance of a line of rails, bonded and fished in the usual manner, always increases with time, they prefer solid joints, and their experience is that Thermit joints are superior to Falk cast-welded ones. Some results are given of e.m.f. measurements between various fixed points, and from these the distribution of stray currents can be inferred. They consider the 7-volt, and the 1·5-volt rules of the Board of Trade as, on the whole, good practical safeguards, but they regard them as unnecessarily restrictive, except in cases where strata, capable of concentrating the current within certain areas, exist. In such cases they may even afford insufficient protection. Equipment details, and a description of experiments on the electrolysis of pipes are given in appendices. *Discussion.*—**C. Hopkinson** maintained that any engine suitable for marine work would also be suitable for traction. He drew an analogy between the conditions when the propellor was out of the water and those existing immediately after the action of a circuit-breaker. **B. Hopkinson,** referring to the appendix on electrolytic action, suggested the substitution, in place of the 7-volt limit, of a limit of 2 volts per mile, with a maximum drop of 10 volts. This, he maintained, would be easier to comply with, and also afford better protection. The 1·5-volt rule he would modify so as to make the permissible current a function of the pipe area. He proposed a limit of 0·1 ampere per sq. m. **R. E. B. Crompton** would like the National Physical Laboratory to undertake an investigation of the electrolytic action of stray currents, with earth plates of various sizes. Many of the effects commonly ascribed to them he believed were really due to leakages, on consumers' premises, from lighting installations. **A. P. Trotter** considered 2 volts per mile too high. He referred to a paper by G. Claude [see Abstract No. 2843 (1900)], giving much valuable information on the question of electrolytic action. He had never seen a case of corrosion due to a tramway worked under Board of Trade rules. Corroded pipes brought forward were invariably found to result from other causes. He described interesting experiments which he had made in the Board of Trade laboratory on alternate-current electrolysis. He hoped the National Physical Laboratory would continue them. The suggested limiting of the current density to 0·1 ampere would doubtless be effective, but it would be impossible to enforce. He invariably recommended proprietors of water pipes to adopt the effective protection of bonding them metallically to the most negative point of the circuit. The joint-jumping current had given trouble in the United States, but, in his opinion, it might be ignored under Board of Trade rules. **W. E. Ayrton** referred to experiments by Perry and himself, to be made the subject of a paper. He had encountered cases of serious corrosion which he considered himself justified in attributing to electric tramway currents. **C. V. Boys** gave figures illustrating the insignificant deformation, owing

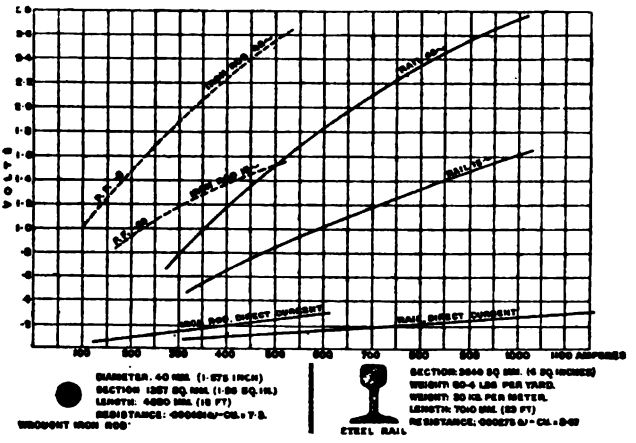
Digitized by Google

to temperature change, of continuously welded straight embedded rails. Some damage to the road-bed might possibly arise on curves, but Continental experience favoured the use of welded joints. **H. Davey** exhibited a model of a Corliss valve trip-gear arrangement which he had devised to shut off steam from each of the cylinders on a pre-determined speed being exceeded, the exhaust valve remaining in action. The engine could then be restarted immediately, without the loss of time involved if the vacuum were destroyed. **A. B. W. Kennedy** had never seen a pipe produced which could be shown to have been damaged by currents from tramways working under Board of Trade rules. He considered any well-governed engine suitable for traction loads. Belliss engines had proved quite satisfactory on the Waterloo and City Railway, which was simply a big tramway with two trains running on it. **E. M. Lacy** considered that a better joint than a welded one could be made by rivetting, through the bottom flanges, underneath the joint, an inverted section of the same rail, with heavy well-designed fish-plates. **B. Hopkinson** in his reply expressed his disagreement with the proposal that the National Physical Laboratory should undertake electrolytic experiments with earth-plates. He contended that the experiments should be made by engineers, with real pipes. He explained that in speaking of high-speed engines the authors had in mind such speeds as those of the Parsons turbine rather than those obtainable with ordinary high-speed engines. *Correspondence.*—**R. Appleyard** gave reasons for believing that experiments with earth-plates would not give much reliable information. **P. Dawson** maintained the advantages of water-tube boilers over the Lancashire boilers preferred by the authors. He advocated the use of compound-condensing engines. Triple-expansion engines should only be used with large storage batteries to equalise the load, but he would not use storage batteries in so large a station as Leeds. He considered the extensive Continental use of storage batteries to be due to a preference for the demonstrable saving in steam consumption, when used in conjunction with triple-expansion engines, rather than the real economy of making the production cost per unit produced as small as possible. He preferred the Falk joint to any other, but it was expensive. It was much superior, in his opinion, to Thermit-welded joints. The **Authors** in their reply explained their preference for Lancashire boilers as being due to the large reserve of heat and steam, making possible heavy draughts of steam lasting for two or three minutes. These were often required, and their experience was that it was seldom possible, or necessary, to provide for any sudden excess load by forcing the boilers ; the excess always disappeared by the time the change in stoking took effect. They were inclined to agree with Dawson that in a station as large as Leeds (7,000-h.p.) a storage battery was of doubtful advantage. In the 4,000-h.p. station at Newcastle it was of the greatest possible use. G. W. DE T.

710. *Electrical Traction on Railways.* **W. M. Mordey** and **B. M. Jenkin.** (Inst. Civil Engin., Proc. 149. pp. 8–49; Discussion, pp. 50–162, 1902.)—In the earlier portions of the paper the authors discuss critically the different continuous-current, alternating-current, and composite systems of working electric railways. The authors point out the necessity for the careful study of rail-resistance with alternating currents of various periodicities when it is proposed to make use of a rail-return for such currents. The accompanying diagram shows the results of some experiments on the resistance of a wrought-iron rod, and a steel rail, of the dimensions given in the diagram,

Digitized by Google

with alternating currents of periodicities 15 and 42 respectively. The curves show the voltage required to send various currents through the conductors. At the lower part of the diagram they are given with continuous current for comparison. The value of the power-factor (P.F.) shows that only 80 to 82



Wrought-Iron Rod and Steel Rail. Apparent Resistance with Alternating Current (*Blathy*).

per cent. of the observed drop represents energy actually lost in the rod; and it may be assumed that a somewhat similar figure would hold for the steel rail. The accompanying table, showing the loss of voltage in rail-return, is deduced from these curves on the assumption that, with alternating currents,

Loss of Voltage in Rail-return.

Total Current in Two 90-lb. Rails. Amperes.	Amperes per Square Inch.	Volts per Mile.			Yards for 7 Volts.		
		Continuous Current.	Alternating Current.		Continuous Current.	Alternating Current.	
			15~	42~		15~	42~
1,000	56·5	21	120	210	585	103	59
900	50·8	19	101	176	650	122	70
800	45·2	16	85	147	730	145	84
700	39·5	14	66	112	885	185	110
600	33·9	12	53	87	972	233	141
500	28·2	11	39	67	1,160	318	185
400	22·6	8	28	50	1,460	446	244
300	16·9	6	21	34	1,950	597	358

for the same current density, the drop for a given distance will be the same in the 90-lb. rails as in the 60-lb. rails of the diagram. This can only be considered approximately true. No allowance has been made for joints. This increase of resistance is a serious matter, but, on the other hand, the transformer substations may be put nearer together without increasing the working expenses, because constant attendance is unnecessary; and, since the use of alternating current makes much higher pressures possible, therefore much smaller currents are used. The authors believe that this high resistance will ultimately lead to the use of an insulated return conductor.

Digitized by Google

After the consideration of the systems in use, the authors give a list of requirements which should be fulfilled by an ideal system. They consider that the nearest approach to such a system will be obtained by working with single-phase alternate current. The system which they put forward is a modification of one suggested by Ward Leonard in 1891, the modification consisting mainly in the use of a self-starting induction motor in place of the synchronous non-starting motor proposed by him. The system consists essentially in supplying alternate current to the cars, and using it to energise ordinary continuous-current motors by the interposition of a motor-generator carried on each motor car. This motor-generator can be started under no load, just before the train starts, and can be kept running during short stops. An appendix gives some results of the working of the Central London, and City and South London Railways during 1901. The paper is illustrated by a number of diagrams illustrative of the various systems considered.

Discussion.—**Kelvin** considered the suggestion of a locomotive sub-station an interesting one, and one whose development would be watched with interest. He thought the possibilities of the constant continuous-current system made it worthy of more attention than it had yet received. **R. E. B. Crompton** considered that the authors had shown the necessity of directing attention to the problem of devising a thoroughly simple variable speed-torque arrangement, but did not think the authors' solution could be accepted as a final one. **A. Siemens** considered that the constant-current continuous system had many advantages. He gave figures which appeared to indicate that for suburban trains running 20 miles an hour, with stops at half-mile intervals, the motor-generator would add some 76 per cent. to the weight of the cars. **P. Dawson** considered that the proposed system would be expensive both in first cost and in maintenance. **A. B. W. Kennedy** pointed out, with regard to the complication and weight of the proposed locomotive, that in these respects it did not compare unfavourably with the steam locomotive. The constant speed required on all gradients was a serious objection. However, the advantages of the single-phase system were so great that the difficulties in the way of adopting it would probably be overcome before the time became ripe for the electrification of main lines. **F. W. Webb** expressed the opinion that the enormous cost of changing over the rolling stock would for a long time prevent the electrification of extensive main lines. The shunting yards also, he thought, would present great difficulties. **J. Holden** considered that economy of wages in main-line working required the trains to be as few and heavy as possible, while economy of electric working would be greatest under the opposite conditions. **S. B. Cottrell** gave interesting details of the high rate of acceleration attained on the Liverpool Overhead Railway. **F. Bramwell** gave some practical illustrations of the high rate of acceleration possible without injury to passengers. **D. Fox**, while agreeing with F. W. Webb, called special attention to the importance, for the purpose of high-speed traffic, of the abolition of reciprocating motion in electric driving. **J. Swinburne** thought that, while main-line electrification was out of the question at present, it was most important, in view of future developments, that suburban lines should not be furnished with systems of electric traction which would be unsuitable for extension to main lines. **J. W. Barry** considered that for suburban work every car should carry motors, which would obviate many of the serious difficulties of working with an electric locomotive, in station yards, for instance. He thought that as so little had been done towards solving the problem of main-line electrification, the question of

Digitized by Google

suburban railway equipment should be decided on its merits in each case, without vainly attempting to provide for what might come about in the future. **W. Geipel** pointed out that motor-generators on the locomotives had the advantage of not requiring extra attendants, and tended also in several ways to give a flexibility approximating to that of the steam locomotive. The authors had referred to possible commutator difficulties, but, from his own experience, he could say that no such difficulties occurred with properly designed motor-generators. **P. V. McMahon** gave interesting details of efficiency and cost of working on the City and South London Railway, and suggested the existence of some errors in the figures given by the authors. He approved the authors' recommendation of a variable-ratio gear as being apparently the only way of overcoming the difficulty of rapid acceleration without an excessively large generating plant. **F. Hudleston** corrected some of the figures given by the authors [and which were given as supplied by the Company] for the efficiency of the Central London Railway. **W. M. Mordey**, in the course of his reply, gave detailed reasons for his opinion that the demerits of the constant continuous-current system outweighed its merits. **B. M. Jenkin**, in replying, observed that the Ward-Leonard system was really a transformation from constant pressure to constant current, if it were desired to keep the current constant; and with the system described by them there was the advantage of constant current in driving the train, without any of the disadvantages of generating, transmitting, and collecting it on the train. The extension of suburban electric lines to the points of contact between neighbouring towns would tend to a high-speed connection between the two centres, and therefore this should be borne in mind in designing the suburban systems. The question of weight efficiency did not appear to have hitherto been carefully considered. On the City and South London and the Liverpool Overhead Railways the dead weight of the train was about 700 lbs. per seat; on the Waterloo and City and the Central London Railways about 1,000 lbs.; on the Metropolitan about 900 lbs. With main-line expresses it jumped up to about 3,800 lbs. Therefore the additions to the weight of the locomotive were insignificant. The kitchen of a dining car added a dead weight of 30 tons to a train; most of this might be saved and put on locomotion if cooking were done electrically. *Correspondence.* — **C. E. L. Brown** agreed with the opinions of the authors, but pointed out, with regard to the objection that lost time could not be made up on a polyphase line, that loss of time chiefly occurred when the traffic was heavy, under which conditions continuous-current motors would run at the slowest speed. It followed that a continuous-current railway, working under economical conditions, viz., without wasting power in rheostats at normal speed, was inferior to a polyphase railway, which would maintain the schedule time during heavy traffic. **E. Huber** stated that the Oerlikon Company had, by a cruder method, arrived at the same conclusions as the authors, and had offered the Swiss State Railways the equipment of a line 12¼ miles long, and the hauling of all scheduled trains on this line, comprising several goods trains daily weighing about 200 tons each. [This offer has since been accepted.] He gave interesting details of a locomotive designed by the Oerlikon Company. **G. Kapp** criticised the authors' method in some detail, and maintained that the consumption of energy was excessive. He suggested lightening and simplifying the motor-generator by transforming to three-phase, instead of to continuous, current. The **Authors**, in the course of their reply, observed that the adoption of G. Kapp's suggestion of transforming to

Digitized by Google

three-phase current would involve the sacrifice of the main feature of the Ward-Leonard system, viz., the independent variable excitation of the generator, which gave the variable-ratio effect and the consequent absence of resistance losses. The method suggested did not appear capable of giving any equivalent of this, except at the cost of variations of the power-factor so great as to more than counterbalance the gain in weight. G. W. DE T.

711. *Surface Contact Tramway: Ramassot System.* **A. Bainville.** (Électricien, 25. pp. 129–131, Feb. 28, 1903.)—This system comes in the category of grouped contact systems, although the contact studs are absolutely independent of each other. The moving core of a solenoid is used to close the circuit between the underground cable and the contact stud, the rails forming the return as usual. The solenoid is not in the contact stud, but may be placed at a convenient distance away. Usually ten, fifteen, or twenty solenoids are grouped in a distribution box placed under the pavement. As the contact studs are fixed every 5 m., the distribution boxes are placed at distances apart of 50, 75, or 100 m. The solenoids which serve to close the circuits to the studs are provided with three windings : one, of thick wire, carries the normal current to the motor ; one, of fine wire, furnishes the necessary ampere-turns to actuate the solenoid ; and the third has about 1,000 ohms resistance. The three windings are connected in series, the free end of the thick wire coil being in direct connection with a contact stud, and the free end of the high-resistance coil being connected to the rails. A difference of potential between the stud and the rails, equal to the line pressure, energises the solenoid. The skate beneath the car is long enough to touch two contacts. When one has been energised, which may be done by means of a battery in the car, the core is pulled up and the stud made "alive." The stud in advance is then energised by the line current through the skate. The floating core of the solenoid, on being attracted, not only connects the line with the stud but short-circuits the fine wire exciting coil, the core being then held up by the thick winding. On the skate passing the contact the core consequently falls. Sectional drawings of the solenoid, contact stud, and distribution box are given, and diagrams of connections. F. B.

712. *Railroad Car Braking.* **R. A. Parke.** (Amer. Inst. Elect. Engin., Trans. 20. pp. 29–69 ; Discussion, pp. 70–87, Jan., 1903.)—The author gives a sketch of the practical development of brakes in railroad service; an analysis of the results of investigation of brake-shoe friction; a definition of the requirements and limitations of brake efficiency in practice, and a consideration of the loss of braking efficiency through disturbance of the normal rail-pressures by brake retardation, and means for compensating for it. In early forms of compressed-air brake, the compressed air was stored in a reservoir on the locomotive and conducted to the brake cylinder on each car by means of a line of iron pipe. The time required for the air to travel along a train, and the danger of total disability due to rupture of the air-pipe at any point gave rise to the automatic air-brake, in which an auxiliary storage reservoir, of sufficient capacity to operate a single brake cylinder, is added to each car. A reduction of pressure in the pipe-line causes the brakes to be applied. The Westinghouse-Galton experiments, conducted on the L.B. and S.C. Railway in 1878, are referred to. The coefficient of brake-shoe friction decreases with increased speeds, and, at constant speeds, decreases with the increase of time of contact. It does not appear to increase with increased pressure per sq. in. From the Galton results the author deduces the following formula

Digitized by Google

to represent the mean coefficient of friction: $f = 0{\cdot}326/(1 + 0{\cdot}03582V)$, in which V represents speed in miles per hour. A table is given of the observed values, and values computed from the above formula, for speeds up to 100 miles an hour. The figures closely agree. Galton assumed that the decline of friction is as the increase of the time of contact, but the results show that it is a function of the product of the speed and the time, or of the distance through which the shoe rubs on the wheel. The doctrine that friction is independent of the area of the surfaces in contact has been the cause of much misapprehension and errors of construction. It has been shown by P. H. Dudley that broad-headed rails yield a materially greater tractive power to locomotives than narrow-headed ones, and it may be assumed that any means of increasing the contact surface between wheels and rails adds to the resistance which measures the maximum efficiency of the brakes. Recent observations show a higher coefficient of rail friction with steel-tired wheels than with chilled iron. The utilisation of the retarding force available as rail friction by means of brakes involves the application of a brake-shoe pressure which shall (*a*) diminish as declining speed causes the coefficient of friction to increase; (*b*) increase as increased distance of frictional contact causes the coefficient of friction to decline; and (*c*) when diminishing or increasing for such purposes, further diminish or increase, as reduction or increase of pressure itself causes the coefficient of friction correspondingly to increase or decline. The use of the automatic "high-speed" brake, which applies increased pressure during the early part of the stop, shortened the time of stop from the higher speeds by 30 per cent. There is also less discomfort to passengers owing to the character of the stop. The act of stopping a car causes a redistribution of the weight, so that to approach as nearly as possible to theoretical conditions, the pressure on the brake-shoes of the forward truck must be different to those on the rear truck. As the cars are reversible, the combinations are very complex. The author then investigates mathematically the distribution of rail pressures, and arrives at the result that any means of making the possible rail-friction of the forward pair of wheels fully available would increase the braking efficiency by more than 17 per cent. Diagrams are given embodying the author's suggestions, the main feature of which is the hanging of the brake beams between the wheels, instead of outside, and inclining the hanger links at such an angle as shall cause increased pressure on the forward brake-shoes and diminished pressure on the rear, no matter in which direction the car may be travelling. The use of magnetic brakes combined with a system of car heating is discussed. The heating effect due to the starting resistances is not in itself sufficient, but when augmented by that due to braking, the heat supply is abundant. The heat supply is intermittent, but it is communicated to heaters which readily absorb it, and gradually and uniformly deliver it to the car. The brake apparatus, which is a combination of a track brake and wheel brake, is described and illustrated. *In the discussion*, **C. Townley** described a test made on a train of three cars, each equipped with motors. When running at about 40 miles an hour, it was attempted to stop the train by the brakes, keeping current on the motors. The effect was to slow the train down to a speed of about 20 miles per hour, when it continued to travel at a constant speed. With brake shoes placed between the wheels, nearly all brake dust ground off the shoes is thrown clear of the motors; but when placed outside, it is thrown on the motors, with objectionable results. **W. O. Gotshall** considered the reverse to be the case. He referred also to some tests which showed that the energy consumption per ton-mile was

Digitized by Google

reduced by about 12 per cent. by using the power brake in preference to the hand brake. In replying to questions and to the discussion, the **Author** said it was obvious that greater brake-shoe pressure necessitates greater wear; but when brake-shoes of the Ross type are used, which wear on the outside of the tread and upon the flanges, and not upon that portion of the tread which is worn by the rail, it is found that tire-dressing by the brake-shoe is cheaper than turning in the shop. He threw out a warning against using the curves and figures given in Keiley's paper [see Abstract No. 655 (1903)] for conditions other than those under which the constants were derived. [See also Abstract No. 2089 (1901).] F. B.

713. *Braking and Brake Tests.* (Amer. Inst. Elect. Engin., Trans. 20. pp. 207–212, Feb., 1903.)—Discussion on papers by **J. D. Keiley** and **R. A. Parke.** [See Abstract No. 655 (1903) and preceding Abstract.] **T. P. Gaylord** referred to the troubles arising from the overheating of motors on cars fitted with electric brakes. The motors do not get the same relaxation during periods of braking and stopping, and in some instances this will make quite a difference in the size of the equipment to be used. **J. R. Cravath** said that a motorman using a straight air-brake needed to exercise judgment, as the full storage tank pressure carried is sufficient to skid the wheels. Apparatus is being exploited, having for its object the increase of traction between rail and wheel by magnetism. It is said that on a 15-ton motor car the tractive effort had been increased by 350 per cent., with an expenditure of energy of 2½ e.h.p. Other speakers said this device was old, and had often been tried, but it cost more in energy than it was worth. **E. B. Clark** gave instances of the breakage of axles due to magnetic braking. **B. J. Arnold** gave some information as to the rapidity of application of the Westinghouse electrically operated air brake, showing that the brakes on the end of a long train were applied more quickly than sound could travel the length of the train. F. B.

714. *Structure of Steel Rails.* (Metallographist, 5. pp. 245–248, July, 1902.) —The paper contains microphotographs which illustrate in a striking manner the influence of sawing upon the structure of the metal in immediate contact with the saw. A hot sawed section has a much finer structure than the normal one, while a cold sawed surface is, if anything, coarser. The photographs were taken by S. S. Martin, of the Maryland Steel Company. He draws the conclusion that the finer grain is due to the hot saw keeping the particles in motion until a temperature below the critical point is reached, when there can be no further growth of crystal, and he considers that the photographs afford a striking illustration of the beneficial effect of hot work upon the structure, and of the importance of low finishing temperatures.
G. W. DE T.

715. *Telephones on Electric Railways.* **Luzzati.** (Elettricità, Milan, 22. pp. 69–71, Feb. 1, 1903.)—The electric lines north of Milan, worked by the Mediterranean Company on the third-rail system, with high-tension overhead feeders, require a telephone service as auxiliary to the telegraphs for working the traffic. As the telephone wires are carried on the same poles as the high-tension feeders, great precautions were necessary to ensure proper working and to prevent accidents. Three telephone wires are run throughout, but as it was desired to be able to use any one of them alone with earth return, the high-tension feeders were twisted three times in each of the sections

Digitized by Google

Tornavento-Parabiago (20 km.), Tornavento-Gallarate (18 km.), and Parabiago Musocco (18 km.). To avoid risks from contacts between the telephone wires and the high-tension feeders all instruments are connected through transformers with earthed shields between the primary and secondary windings. A. E. L.

ELECTRIC LAMPS AND LIGHTING.

716. *Intermittent Currents for Electric Lighting.* **S. H. Holden.** (Elect. Rev. 52. pp. 132–133, Jan. 23, 1903.)—The author imagines a pulsating current produced by an alternating e.m.f. of 100 volts (assumed to arrive instantaneously at its full value at each reversal) superposed upon a continuous e.m.f. of the same value in the same circuit. The result will be the same effective current as in the case of either e.m.f. acting singly, but passing under a doubled e.m.f.; the consumption of energy in the circuit will therefore be doubled. From such a supply the periodic element might be eliminated by a choking coil, and the direct-current element by a transformer, through the primary of which the pulsating current might be passed. Thus, if pulsating current were supplied where continuous current is at present in use, a circuit might be fed from either indifferently, and it would be possible to arrange that certain lamps (say street lamps) were only lighted up when the current became pulsating; or that certain motors were only able to run during one or the other period. Another advantage suggested as resulting from a supply of this character is the possibility of discriminating by the use of two meters on the consumer's premises, an alternating and a continuous one, between the consumption during the hours of heavy and light load, and arranging the tariffs accordingly. By this means it would be possible for the consumer, by noticing whether his alternating meter were at work or not, so to regulate his use of current as materially to improve the load curve at the station, while at the same time benefiting his own pocket. Other advantages of the system are suggested. B. P. S.

717. *Photometry of Incandescent Lamps.* **J. T. Marshall.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1483–1491; Discussion, pp. 1500–1509, Nov., 1902.)—The Edison General Electric Co. has for many years determined the voltage of lamps by a sliding scale photometer. If two lamps of the same candle-power but of different voltages are balanced against one another on the photometer, the ratio of their voltages can be determined directly, if a suitable scale is provided. If, therefore, the voltage of the one lamp is known, that of the other is determined. The scale is made by combining the curves of the candle-power scale of the photometer with the curve showing the change of candle-power due to change of voltage. The former curve has the position on the photometer, at which the balance is found, for abscissa, and the ratio of the candle-powers of the lamps for ordinates; the second curve has the candle-power of the lamp for ordinate, and the voltage for abscissa. An error arises from the fact that this last curve depends on the treatment to which the lamp has been submitted during the flashing process. Curves are given showing the effect produced by varying amounts of deposited carbon. The average filament has its resistance reduced to 87·5 per cent. of its initial amount. A so-called differential photometer is also described. A voltmeter shows the difference in voltage of the two lamps. One terminal of the voltmeter can be slid along the resistance in series with the standard lamp; the volt-

Digitized by Google

meter then reads the voltage of the reference lamp used in setting the photometer. By changing the position of the screen the photometer can be used with the same setting for lamps of all candle-powers that come within the range of the voltmeter. Another form of photometer is also being tested, using alternate current from a transformer having single volt steps. The lamp is brought to its rated candle-power by connecting it to the proper step of the transformer, and its volts are given by noting the number of steps between the tested and the standard lamps. W. H. S.

718. *Photometry of Electric Lamps.* **J. A. Fleming.** (Inst. Elect. Engin., Journ. 82. pp. 119–171; Discussion, pp. 171–215, Feb., 1908.)—The author points out that even in expert hands photometric determinations are liable to serious errors, the readings differing in some cases by 25 per cent. even with incandescent lamps. This seems to show that grave uncertainties still exist. A large number of photometric standards are in use. In this paper full particulars are given with regard to most of the more important ones, including the Harcourt pentane lamps, the Hefner amyl-acetate lamp, and the Violle molten platinum standard, together with the corrections to be applied in the use of these. As an instance of the uncertainties of photometry, it may be pointed out that some observers have found the Hefner unit to be equal to 0·98 British c.p., while others have made it as low as 0·872. The most probable value appears to be 0·88, the mean of the Reichsanstalt values being 0·876. Some form of platinum standard has possibilities, but so far nothing very practicable has been evolved. The author has used an incandescent lamp as a standard with very satisfactory results. These are made as follows. Carefully selected carbon filaments are mounted in ordinary bulbs, and run for 50 hours at 5 per cent. above their normal voltage. They are then remounted in bulbs 6 or 8 in. in diameter, and if they are not much used or run above a certain voltage, they remain constant for a long time. In fact, after six years it was impossible with certainty to detect any change in such lamps. The light emitted by 1 sq. m. of the crater of an arc has been suggested as a standard, but the values assigned to this unit vary from 140 to 170 candles, and hence it is not likely to be useful as a standard, apart altogether from physical difficulties connected with its use and the fact that the quality of the light is very different from that of most secondary standards. The question of photometers is next considered, and an arrangement of a photometer bench and potentiometer is shown by which results can most easily be obtained. On this system a Lummer-Brodhun photometer is used, and balance is obtained by moving one of the lamps which is carried on a sliding table, worked by an endless cord and a winch below the photometer bench. An apparatus is also described for the convenient determination of the light emitted by an arc lamp in different directions, and this is used in conjunction with Abney's variable aperture disc. A geometrical construction is given by which, from the polar curve of luminous intensity of an arc, the illumination on a roadway from any number of such arcs placed at any heights and distances can be plotted. In comparing lights of different colours great complications arise, and even if an apparent balance is obtained with the lights in certain positions, this balance is disturbed by moving the lights to half their previous distances. Crova states that the integral brightnesses of two nearly white lights are in the ratio of the brightness of the rays in them having a wave-length of 0·582 μ. He therefore views the lights through a glass trough containing a solution of ferric and nickelous chlorides. Rood and Whitman have suggested various forms of flicker photometer, by which

Digitized by Google

the two lights are seen, one at a time, in rapid succession. Helmholtz, however, considered that heterochromatic photometry was impossible, and no scientific meaning could be attached to such an expression as the candle-power of an arc. With regard to units, the author considers the candle obsolete, and suggests that 10 candle-power might be called 1 lamp-power, and this might lead to a more simple classification than the existing 8 c.p., 16 c.p., &c. The paper concludes with a bibliography of the subject, extending over the last thirty years. *In the discussion,* **A. Vernon Harcourt** stated that he had found that the light given by an arc lamp in a lighthouse could be easily compared at a distance of several miles with his 1-c.p. standard, and the readings taken by wholly unskilled observers agreed reasonably well. A Bunsen photometer was used, having a translucent disc with serrated rim and opaque margin. **R. T. Glazebrook** referred further to Petavel's work on the Violle standard, and stated that experiments with iridium and other metals of that group were more hopeful. He also gave further particulars and curves relating to Petavel's work. **W. de W. Abney** considered that flicker photometers were unsatisfactory for colour photometry: with the oscillation method, which he described, an exact balance can be obtained without any flickering whatever. **J. E. Petavel** stated that, with the Violle standard of molten platinum, an increase or decrease of 40 per cent. of the molten metal causes a variation of less than 1 per cent. in the light; a similar variation is caused by an alteration of 45 per cent. in the mass of the platinum ingot; an alteration of 140 per cent. in the size of the aperture in the furnace cover causes a variation of less than 1 per cent. in the light; the platinum must be pure, and the crucible of pure lime; the hydrogen must be free from hydrocarbons, and the gases should be in the ratio of 4 volumes of hydrogen to 8 of oxygen. W. H. S.

REFERENCES.

719. *Extra High-Pressure Transmission Systems.* **W. Blanck.** (Zeitschr. Elektrotechn., Wien, 21. pp. 17–23, Jan. 11, 1903. Report read before the Elektrotechnischen Verein at Vienna, Nov. 19, 1902.)—In this report the author summarises the essential features of some of the principal transmission systems in the United States in which exceptionally high pressures are employed. G. W. DE T.

720. *Calculation of Alternate-Current Networks.* **A. Luraschi.** (Elettricità, Milan, 21. pp. 483–485, Aug. 3, 1902.) A. E. L.

721. *Graphical Treatment of Conducting Networks.* **G. König.** (Elektrotechn. Zeitschr. 24. pp. 69–72, Jan. 29, 1903.)—The author shows how the ordinary funicular polygon method of representing the voltage-drop along any member of a conducting network may, by a suitable choice of poles, be utilised for any given values of the cross-section if once constructed for a cross-section of unity. A. H.

722. *Electric Power Transmission in Switzerland.* (Engineer, 94. pp. 296–297, Sept. 26; 366–367, Oct. 17; 409–410, and 414–418, Oct. 31; 461–465, Nov. 14; and pp. 516–518, Nov. 28, 1902.)—These papers contain a very fully illustrated description of the St. Maurice and Lausanne transmission system and other power plants which have already been referred to in preceding Abstracts. G. W. DE T.

723. *Water Power at Burlington, Vermont.* **A. D. Adams.** (Elect. World and Engineer, 41. pp. 147–148, Jan. 24, 1903.)—A description of a turbine station on the Winooski River, about 3 miles from Burlington. W. H. S.

Digitized by Google

724. *Water Power in Switzerland.* **F. Loppé.** (Écl. Électr. 33. pp. 289–294, Nov. 29; 337–342, Dec. 6; 370–376, Dec. 13; and pp. 397–403, Dec. 20, 1902.)—A description of the water-power plants at the Simplon tunnel works, at Vouvry [see Abstract No. 371 (1903), at St. Maurice [see Abstract No. 1449 (1902)], and at Chèvres [see Abstract No. 579 (1901)], visited by the Congrès de la Houille Blanche. A. E. L.

725. *Fault Localising on Tramway Systems.* **A. Johnston.** (Elect. Rev. 52. pp. 47–48, Jan. 9, 1903.) F. B.

726. *Direct-Current Power Transmission at Lausanne.* **Wyssling.** (Elektrotechn. Zeitschr. 23. pp. 1001–1005, Nov. 13; 1016–1021, Nov. 20; and pp. 1038–1042, Nov. 27, 1902.)—A full description of this installation, which transmits power to Lausanne over a distance of 55 km. from a fall on the Rhone at St. Maurice [see also Abstracts Nos. 1369 (1900), and 1449 (1902)]. A further description of this power-station appears in the Zeitschr. Vereines Deutsch. Ing. 47. pp. 73–81, Jan. 17, 1903. W. H. S.

727. *Electrical Equipment of the Lowson Flax Mills, Arbroath.* (Engineering, 75. pp. 221–226, Feb. 13, 1903.)—A description of this installation with drawings showing how the motors have been installed for the purpose of driving the shafting. W. H. S.

728. *Electric Power in American Navy Yards.* **W. S. Aldrich.** (Amer. Soc. Naval Engineers, Journ. 14. pp. 448–457; 814–824; and pp. 1109–1122, 1902.)—The author deals generally with the advantages of electric driving for factory work, more especially with regard to the requirements of the Navy yards. From the point of view of the transmission system to be adopted, the Navy yard is simply a very extensive factory, comprising a large number of shops, with a wide range in the class of work to be dealt with, which varies from the heaviest to the lightest character. Under such conditions the author [as was to be expected] favours the use of alternating, and preferably polyphase, current. G. W. DE T.

729. *London County Council Tramways.* (Engineering, 74. pp. 431–432, 434, Oct. 3; 495–497, 498, 510, Oct. 17; 698–701, Nov. 28; and pp. 773–776, Dec. 12, 1902.)—A full description with a large number of drawings. [See also Abstract No. 207 (1903).] W. H. S.

730. *Nottingham Tramways.* (Tram. Rly. World, 12. pp. 701–709, Dec., 1902.)—A general description of the completed work. [See also Abstract No. 1426 (1901).]

731. *Commercial Management of Electric Tramways.* **T. W. Sheffield.** (Feilden, 8. pp. 59–67, Jan., and pp. 129–138, Feb., 1903.)—A general article dealing with the carriage of goods, signalling, point switching, car regulations, lifeguards, brakes, and track cleaning. Illustrated by photographs of cars, &c. F. B.

732. *Equipment of Railways with Converter Substations.* **A. D. Adams.** (Street Rly. Rev. 13. pp. 80–82, Feb., 1903.)—A compilation of data referring to the substation equipment of American railways. F. B.

733. *Electric Traction in the United States.* **G. Gillon.** (Soc. Belge. Élect., Bull. 19. pp. 561–589, Sept., 1902.)—A general survey of American work and the systems commonly used on the various classes of electric tramways and railways. W. H. S.

734. *Graphical Treatment of Traction Problems.* **R. Mauermann.** (Elektrotechn. Zeitschr. 24. pp. 26–29, Jan. 8, 1903.)—The author shows how the mechanical characteristics of the motors used may be applied to the graphical solution of electric traction problems. A. H.

Digitized by Google

TELEGRAPHY AND TELEPHONY.

735. *Wireless Telegraphy in the United States Navy.* **A. M. Beecher.** (Amer. Inst. Elect. Engin., Trans. 19. pp. 1259–1268; Discussion, pp. 1424–1482, Oct., 1902.)—After a brief general discussion, the author states that the masts of all ships in the United States Navy are now being altered and prepared for the installation of wireless telegraph apparatus. For this purpose, their former maximum height of 120 ft., fixed to enable them to pass under Brooklyn Bridge, is being increased to about 185 ft., provision being made for housing the mast when required. The upper portion of the mast, at least 50 ft., is of wood, and is stayed with hemp rigging, or in the case of rigging coming lower down than 15 ft. from the masthead, it may be of wire set up with hemp lanyards. Wireless telegraph masts have been, or are being, erected at the principal naval stations. The author states that it is proposed to test thoroughly all the various kinds of wireless telegraphic instruments at the several shore stations and on board naval vessels, and after determining upon the system best adapted to varying service conditions, it will be adopted as the standard for the service, and all naval vessels will be supplied with it. G. W. DE T.

REFERENCES.

736. *Wireless Telegraph Experiments on Board the "Carlo Alberto."* **L. Solari.** (Electrician, 50. pp. 22–26, Oct. 24, 1902. Abridged translation from "Radio Telegrafia.")—The author describes in somewhat general terms the apparatus used at the transmitting station of Poldhu and on board the vessel. The rest of the paper consists mainly of a diary giving the results of signalling from day to day. Signals were detected at distances extending up to 1,540 km. G. W. DE T.

737. *Wireless Telegraph Experiments on Board the "Carlo Alberto."* **N. Maskelyne.** (Electrician, 50. pp. 105–109, Nov. 7, 1902.)—This is a critical commentary on the paper dealt with in the preceding Abstract, based on readings taken by the author at Porthcurnow of the signals transmitted from Poldhu. G. W. DE T.

738. *Recent Wireless Telegraph Patents.* (Electrician, 50. pp. 140–142, Nov. 14; 185–187, Nov. 21; and pp. 230–233, Nov. 28, 1902.)—These papers contain short illustrated descriptions of some of the principal wireless telegraph patents taken out during the years 1899–1901. G. W. DE T.

739. *Lausanne New Telephone Exchange. Detailed Description of Central Office Apparatus on Branching System.* **L. Vanoni.** (Journ. Télégraph. 26. pp. 265–270, Dec., 1902; 27. pp. 6–9, Jan., and pp. 25–33, Feb., 1903.)

740. *Multiple Switchboard for Telephone System.* **Dankwardt.** (Archiv Post Tele. 21. pp. 655–669; and 22. pp. 687–701, Nov., 1902.)—This is a description of the telephone system referred to in Abstract No. 424 (1902). It is a very elaborate description, giving details of apparatus and diagrams of connections. R. A.

741. *Evolution of the Telephone Switchboard.* **T. D. Lockwood.** (Amer. Inst. Elect. Engin., Trans. 20. pp. 127–154; Discussion, pp. 179–194 and 197–205, Feb., 1903.)—The paper gives an historical account of the development of the telephone exchange, and an analysis of the mechanical and electrical features of telephone switchboard apparatus from 1877 to date.

Digitized by Google

SCIENCE ABSTRACTS.

Section B.—ENGINEERING.

OCTOBER 1903.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

742. *Trials of a Steam Boiler with Three Internal Flues.* **L. Lewicki.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 926–930, June 21, 1902.)—These were made with a Lancashire boiler having a third internal flue below the two main flues; the flue starts at the back of the boiler, and the other end of it opens into the external flue underneath, at a point about 8,400 mm. from the front of the boiler. The gases pass from the back through these two flues and return through two side flues. A superheater is installed at the top of the combustion chamber at the back of the boiler. The following details relate to a trial conducted by the author on May 31, 1901:—Duration of trial, 8 hours 3 minutes; weather fair, warm, and calm; temperature of boiler-room, 31·78° C.; temperature of feed-water, 12·9° C.; barometer height, 756 mm. *Boiler.*—Total heating surface, 80 sq. m.; mean diameter, 2,300 mm.; internal length, 8,400 mm.; internal diameter of fireplaces, 875 mm.; internal diameter of three internal flues, 650 mm.; steam-room, 6·45 cub. m.; water-room, 18·58 cub. m.; grate surface, 2·8 sq. m.; superheating surface, 16 sq. m.; damper opened, 875 mm.; draft above grate, 7·5 mm.; draft at damper, 14–15 mm. *Fuel.*—Calorific value (Silesian coal), 6,988 H.U.; total consumption in 8 hours 3 minutes, 2,382 kg. *Gases.*—Carbonic acid gas at end of main flues, 16·43 per cent.; oxygen at end of main flues, 1·16 per cent.; carbonic acid gas at entrance to chimney, 12·14 per cent.; oxygen at entrance to chimney, 6·43 per cent.; temperature at superheater, 690° C.; temperature at entrance to third internal flue, 704° C.; temperature on leaving third internal flue, 443° C.; temperature at entrance to chimney, 376° C. *Steam.*—Effective pressure, 8 kg. per sq. cm.; temperature of saturated steam, 173·6° C.; temperature of superheated steam, 216° C.; total heat in 1 kg. saturated steam from 0°, 659·45 H.U.; total heat in 1 kg. superheated steam from 0°, 679·80 H.U.; total amount of feed-water in 8 hours 3 minutes, 17,526 kg. *Heat transferred through the heating surface.*—1 sq. m. heating surface transferred per hour, 17,586 H.U.; 1 sq. m. superheating surface transferred per hour, 2,769·4 H.U.; total heating surface transferred per 1 kg. of coal, 4,859·4 H.U.; superheating surface transferred per 1 kg. of coal, 152·4 H.U. *Heat losses.*—Loss through the chimney per

Digitized by Google

1 kg. of coal, 1,278·07 H.U.; losses due to incomplete combustion, radiation, &c., per 1 kg. of coal, 646·87 H.U.; total heat loss, 27·76 per cent. *Efficiency.*—Efficiency of boiler, 70·04 per cent.; efficiency of boiler and superheater, 72·24 per cent. From the results of another trial with the same boiler, and a subsequent trial with a two-flue boiler of a somewhat similar size, the author finds that the circulation of the water is so much greater in the three-flue boiler that it is 1·6 times quicker in getting up steam, and that the temperature throughout the water is equalised 1·8 times quicker than in the two-flue boiler. The paper is illustrated with drawings of the three-flue boiler and curves relating to the results of the trials. [See also Abstract No. 1407 (1902).]
C. C.

743. *Conductivity of Boiler Scale, &c.* **W. E. Ernst.** (Akad. Wiss. Wien, Sitz. Ber. 111. 2a. pp. 928–929, July, 1902. From the Physikalisch-chemische Institut der k. k. Universität at Vienna.)—In order to test whether the scale, &c., that settles on boiler surfaces is really conducive to boiler explosions and the burning of the boiler plates, the conductivity of ten specimens of scale, three of lubricators, two of tar, and one of an anti-scale substance were measured at about 30° C. by Christiansen's comparison method. The conductivity of the scale varied between 0·00818 and 0·00768 (*i.e.*, from 3 to 7·4 times that of water), and that of the other substances between 0·000253 and 0·000824. Calculations are made, by means of these numbers, of the temperatures of scale-covered surfaces under certain ordinary conditions of steam pressure and generation, and their results thoroughly justify the usual notions on the subject. The conductivity of one of the specimens of scale diminished by 15 per cent. when its temperature was raised to 110° C.
R. E. B.

744. *Boiler Explosion.* **C. Bach.** (Zeitschr. Vereines Deutsch. Ing. 47. pp. 25–27, Jan. 3, 1903. Paper read before the Württemburg Local Section, Nov. 23, 1902.)—The author deals with a boiler explosion which was traced to weakness caused by a manhole in a cylindrical boiler. He constructed two small cylindrical vessels for experimental purposes; the one without manhole, and the other with one of the usual shape, with the longer axis of the ellipse in the direction of the axis of the boiler. The former burst under water pressure corresponding to 67 atmospheres, and the latter under a pressure of 22 atmospheres. From calculations here given, it appears that the one was 3·27 times stronger than the other. He considers that the manhole constitutes a very weak spot in boiler construction, unless the boiler-plate is unusually strong, or the edges of the manhole are sufficiently strengthened. Moreover, the plan of putting the major axis of an elliptical manhole in a direction parallel to, instead of perpendicular to the axis of the boiler is a serious error in design.
W. H. S.

745. *Plain and Roller Bearings.* **R. Stribeck.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1341–1348, Sept. 6; 1432–1438, Sept. 20; and pp. 1468–1470, Sept. 27, 1902. Paper read before the Württemburg Bezirksverein, Dec. 5, 1901.)—The author maintains that the prevailing uncertainty among engineers as to the cases where roller bearings are applicable arises far more from the difficulty of obtaining reliable data with regard to plain bearings than from want of data respecting roller bearings. The study of bearings must not be confined to steady motion. The starting and accelerating conditions are of the utmost importance, especially in the case of car bearings, also

Digitized by Google

in the case of cranes. It usually takes some hours from starting before a steady temperature is attained, and the friction of plain bearings is usually greater while the temperature is rising than after the steady condition has been attained. Permissible loads, and the factors of safety to be taken, require careful investigation. Except in the case of very short shafts, there is always some deformation, from static or kinetic stresses; the author therefore prefers, except in such cases, a comparatively soft metal for the brasses, such as the bronzes made for the purpose, or antifriction metal. Even where the deformation is negligible, it is difficult, in the first place, to make with accuracy the requisite allowance for the thickness of the oil film. Experimental figures and curves are given showing the increase of viscosity with temperature of various lubricants. They approximate in value as the temperature increases, and at 80° C. there is little difference in this respect between colza oil and the thicker mineral oils. Experiments with ring-oiled cast-iron bearings showed considerable temperature differences between different portions of the oil film, and between the latter and the adjacent portions of the shaft and journals. The differences are greatest soon after starting, and fall to a minimum when the permanent temperature conditions are attained. Curves are given showing the resulting variation in the viscosity of the lubricant, and as it may take several hours for the permanent state to be reached, it follows that the friction losses occurring in motors running intermittently, crane- and vehicle-motors for example, may be seriously underestimated if deduced from measurements made under permanent temperature conditions. Curves are given showing the relation between the coefficient of friction and the load per unit area of the rectangle formed by the bearing length and the diameter of the shaft, at a temperature of 25° C., selected as most suitable for a wide range of speed, and at speeds varying from 5·5 to 1,100 r.p.m. In all cases the coefficient of friction at first decreases rapidly as the load increases, and then, in the case of the lower speeds, rises rapidly, passing through a minimum. As the speed increases, the load for which the coefficient is a minimum increases, until ultimately the curves tend to become asymptotic to the load-axis. Another series of curves shows the relation between the coefficient of friction and the velocity for various loads. At all loads, the coefficient at first decreases with increasing velocity, and the velocity for which it is a minimum increases with the load. They also show that the static coefficient of friction is independent of the load, within the limits of the experiments, which extended from loads of 0·42 kg. to 22·6 kg. per sq. cm. The great change in the coefficient of friction produced by a very small change in the pressure on the bearing at low speeds makes measurements under these conditions unreliable, especially in the case of shafts of small diameter, for very slight deformations, or variation in smoothness between one shaft and another, would cause sufficient pressure changes to considerably affect the results, and there would be no possibility of ascertaining their amount. The initial decrease in the coefficient of friction with increasing speed is doubtless closely connected with the increase in the thickness of the oil-film. With regard to the phenomenon of "seizing" in shafts running at high speeds, it must be borne in mind that, in practice, the temperature increases considerably at high speeds, and the resulting increase of viscosity tends to diminish the thickness of the oil-film. The next series of experiments was carried out with Magnolia metal bearings, the first point dealt with being the conditions affecting the truing up of a new bearing by running. The bearing was run with American spindle oil, a very fluid oil, at 64 r.p.m., and with loads which were gradually increased from 11·5 to 48·6 kg. per

Digitized by Google

sq. cm. Throughout the process there was a continual improvement in the bearing, shown by a continuous decrease in the coefficient of friction at a given load. This occurred in spite of the fact that, during several of the later stages, the increase of the load led to temporary "seizing," which became permanent at the last load. Further trials with more viscous oils showed that the use of thin oil facilitated rapid trueing. Various lubricants were tried when the bearing was in full running order. The spindle oil was satisfactory up to loads of 86·3. Paraffin oil gave nearly identical results up to this load, and ran for a short time with a load of 51·5, but then heated rapidly. With castor oil the friction was high. Water lubrication was tried, with the result of rapid heating and destruction of the bearing surface. The friction-load curves taken at various speeds show that the increase of friction begins at much higher loads than in the former case. The static value of the coefficient of friction f was higher than before, varying from 0·21 to 0·24 with loads varying from 2 to 60. This was evidently due to the more complete contact between shaft and journals giving a larger true bearing surface. For the same reason the values of f at low loads are mostly greater for the Magnolia metal bearing. Curves for the cast-iron bearing, showing the relation between f and the bearing temperature, agree very closely with similar curves taken with the Magnolia metal bearing when the loads on the latter were about double those on the former. The author finally describes a long series of experiments on several distinct types of roller bearing, both with unhardened and hardened rollers. The former he finds to be only suitable for quite light loads, and, where starting effort is comparatively unimportant, they show practically no advantage over plain bearings to compensate for their higher cost. The investigations show that the pure rolling friction is independent of the speed, and decreases as the load increases up to very much higher limits than in the case of plain bearings. Even in the limiting case of no speed the friction is very little greater. This means a very great reduction in starting effort, especially with heavy loads. Such increase of friction as was observed with increasing speed was clearly due to the sliding friction between the rollers themselves or between the rollers and the guides employed to keep them apart. With hardened rollers comparatively heavy loads are permissible. G. W. DE T.

746. *Testing Indicator Springs.* **H. F. Wiebe** and **R. Schwirkus.** (Zeitschr. Vereines Deutsch. Ing. 47. pp. 54–59, Jan. 10, 1903. Communication from the Physikalisch-Technische Reichsanstalt.)—Slaby's two methods of testing have been adopted. According to the first, the spring is loaded by placing the weights in position carefully and noting the reading. According to the second, after the load is put on a slight oscillation is caused in the spring by means of hand pressure, and after ten double swings the spring is allowed to settle down and the reading taken. Slaby found that a given load produces a smaller compression in the first than in the second case. This result is not altogether confirmed by the Reichsanstalt in these tests. Such difference as exists is supposed by some to be due to a lateral pressure induced by the loaded spring, causing increased friction on the walls of the cylinder. The extent of the oscillation produced in the second of the above-mentioned methods produces a slight but uncertain result. When testing the springs with steam, the friction in the cylinder is increased, and the elasticity of the spring is altered. Moreover, with increasing pressures, the readings differ from those obtained with decreasing pressures. It is not desirable to merely take an extreme reading with the spring and to assume that the intermediate

Digitized by Google

readings can be calculated proportionally. Such readings are incorrect. Any difference in reading due to increasing and decreasing pressures must be smoothed out by taking the mean of the two. The temperature of the spring, when hot, is very uncertain. Figures have been given showing the temperature in the spring chamber; but the temperature of the spring itself is almost certainly higher than this, since it is in metallic connection with the piston, which is in contact with the steam. In the tests here described, the temperature was determined by a thermo-couple, consisting of a wire of copper and constantan, the junction being bound to the spring, and the free ends brought through the cover of the indicator cylinder in a porcelain tube. The figures here given show that the temperature of the spring was on an average 11° below that of the steam, and 5° above that of the spring chamber, both these figures being lower than those generally supposed to be true. With a leaky piston it was, however, found that the temperature of the spring was lower than that of the spring chamber. Comparing the results obtained with the cold spring and with the hot spring, the extension of the spring increases by 0·042 per cent. per 1° C. The figure given by Roser was 0·08728. The question also arises as to what the temperature of the spring really is during the act of indicating an engine, and experiment seems to show that this does not depend alone on the mean steam pressure. Possibly the simplest way is to determine the temperature of the spring chamber, and then to assume that the mean temperature of the spring itself is 5° C. higher than this. W. H. S.

747. *Elisha Gray's Electromechanical Governor for Steam Engines.* (West. Electn. 82. p. 129, Feb. 14, 1903.)—In this governor an equilibrium valve is moved by two cores which are mounted on opposite sides of a pivoted lever connected to the valve-spindle. These cores respectively extend into two oppositely arranged solenoids, so that one acts to open the valve and the other to close it. The circuits of these solenoids are connected in parallel to one terminal of a battery, one or other of the circuits being completed, as required, by the following centrifugal device: On a part rotated by the engine at a high rate of speed is mounted a box having an annular concentric space in which is pivotally mounted a circumferentially extending contact-lever connected to the other terminal of the battery above mentioned, and acted upon by a spring tending to draw it towards the axis of the box. The free end of this lever plays between two contacts connected respectively to the ends of the two solenoid circuits. By this means, when the engine is running at its normal speed, the contact-lever floats between the contacts, but when the speed varies the contact-lever touches one or other contact, accordingly as the centrifugal force or that of the spring is the greater, and the valve is moved to correspond. In operation, the contact-lever is in more or less continuous vibration. A modification is described in which the centrifugal device is combined with an ordinary ball-governor acting as an auxiliary on the contact-lever. C. K. F.

GAS AND OIL ENGINES.

748. *Experiments with Internal Combustion Engines.* **E. Schimanek.** (Zeitschr. Vereines Deutsch. Ing. 47. pp. 81–88, Jan. 17, 1903.)—The paper consists of notes of tests on Banki engines made by Messrs. Ganz and Co. These engines have a device for admitting a water spray during the suction stroke, and it is claimed that this enables a higher compression to be reached without pre-ignition. Table I. shows the calculated effect of the injected water

Digitized by Google

on the temperature and efficiency of the engine. This table is not checked by experiment. Data assumed are: Heat supply, 400 units (kilocalories ?); compression from 10 volumes to 1 volume. No account is taken of the result of chemical change during explosion, but the problem is treated as if the cylinder contained air and steam only throughout. Ratio of weight of water to weight of air taken to represent three cases: (1) Ratio 0. No water injected. (2) = 0·0363, water insufficient to saturate the charge. (3) = 0·12, just enough water to be totally evaporated at end of compression. (4) = 0·177, suitable condition for working with benzln.

TABLE I.

	Specific Heat of Products of Combustion assumed Constant.					Specific Heat of Products assumed to vary in accordance with the Mallard Le Chatelier formula.				
Ratio. $\frac{\text{Weight of water}}{\text{Weight of air}}$	0	0·0363	0·08	0·12	0·177	0	0·0363	0·08	0·12	0·177
Temperature before compression C	400	308	308	308	308	400	308	308	308	308
Temperature after compression C	1030	775	530	395·6	393	892	712	518	396	393
Temperature after explosion	3400	3045	2705	2485	2260	2320	2145	1966	1838	1700
Temperature after expansion.....	1320	1210	1100	1020	950	1370	1260	1150	1069	985
"Thermal efficiency"...	61·1	60·2	58·4	56·3	52·7	46·97	47·95	47·68	46·79	44·24

The actual engine tests as reported are anything but systematic; no temperature observations are reported, nor in the majority of cases were diagrams taken; nor are the results tabulated. Considerable space is devoted to the description of mechanical details of the engines. Some results are the following: Benzin as fuel—heating power 10,270 kilocalories per kilo. Engine tested, 16-h.p. Banki engine. Mechanical efficiency 80, thermal efficiency (scale not stated), but from heat in fuel to energy delivered by engine 29·6 per cent. Compression 10 to 1. Consumption of benzin 207 grms. per h.p.-hour (delivered ?). Similar tests are reported on a 1½-h.p. engine. In this case a comparison is instituted between the running of the engine with a compression of 3·6 to 1 unsprayed, and the same engine with a compression of 5·81 to 1, using the water spray. The output is increased by 30 per cent. in the latter case, and data as to consumption of fuel and water are given; and it is stated that the regularity of the electric ignition is not affected by the water spray. Tests were made on a 20-h.p. engine with alcohol as fuel. The consumption is about 400 grms. alcohol (87 per cent.) (volume per cent.) and 200 grms. spraying water per h.p.-hour. The water spray is not so important in alcohol engines, as pre-ignition does not occur so easily. R. T.

AUTOMOBILISM.[1]

749. *Municipal Motor Waggons.* **A. Sharp.** (Mech. Eng. 10. pp. 858–862, Dec. 27, 1902. Paper read before the Conference of Engineers and Surveyors, Sanitary Institute Congress, Manchester.)—In spite of the apparently heavy

[1] Electric Automobiles are described in the Section dealing with Electric Traction.

Digitized by Google

first cost, the saving in working expenses as compared with the horse-drawn vehicles is considerable. The first cost of a modern municipal steam vehicle, with dust-van, water-tank, sweeper, &c., compares favourably with that of eight or ten horses, five dust-carts, four water-carts, and four horse-sweeping machines, which it replaces. At Hampstead it is found that the motor water-cart replaces four horses and carts. One motor dust-cart has twice the speed and two and a half times the capacity of a horse-cart. At Kensington the Thornycroft standard steam waggon has been adapted to carry a water-tank and rotary brush, and can do 14,000 sq. yds. per hour. It has replaced eight horse-sweepers. The author is of opinion that, up to the present, steam holds the field as the motive power for municipal waggons. Internal combustion engines have not proved so satisfactory as steam engines for this kind of work. C. C.

750. *Benzine-Electromobiles.* **W. A. T. Müller.** (Centralblatt Accumulatoren, 4. pp. 3–5, Jan. 1, and pp. 13–14, Jan. 15, 1903.)—A suggestion that the use of a battery might be avoided in an electric car by employing a benzine motor to drive a dynamo, which would supply current to motors worked on the series-parallel system. This would combine the advantages of the benzine motor as a source of power with the advantages of an electric system in the matter of speed control, besides which, the car would have less dead weight than one worked by accumulators. W. H. S.

751. *Minerva Cars.* (France Automobile, 7. pp. 746–747, Nov. 22, 1902.)—All sizes of these motors for 1903 are distinguished by the inlet valves being mechanically operated, the inlet and exhaust valves being situated on opposite sides of the cylinder, each with its separate two-to-one gear and cam. A gain in power, over the ordinary inlet valve, of about 20 per cent. is claimed. The sizes are: With one cylinder, 6 h.p.; two cylinders, 8 and 12 h.p.; four cylinders, 16 h.p., the cylinders all being separate castings so as to be separately replaceable in case of damage. Control is by centrifugal governor acting on a butterfly valve in the mixture pipe; while the speed at which the governor is set can be varied by a hand regulator down to 200 r.p.m. A plan of the 8-h.p. chassis, and photographs of the 6-h.p. chassis and two-cylinder motor are given. The frame is of hickory faced with steel, a dropped steel underframe supporting the motor and change-speed gear. This latter is of the usual sliding type, giving three speeds forward and one reverse, but the drive on the high speed is designedly not made direct, thereby saving the use of two extra pinions, which would reduce the efficiency on the lower speeds. The transmission is by cone clutch, jointed tail-shaft and bevel gear to the live axle, which contains the differential. L. H. W.

752. *Delahaye Cars with Vertical Motors.* (France Automobile, 7. pp. 764–767, Nov. 29, 1902.)—Besides continuing the manufacture of the light car [see Abstract No. 885 (1902)] and a two-cylinder delivery van of 12 and 16 h.p., all with horizontal motor, this firm has adopted for its new types for 1903 a vertical cylinder motor under a bonnet. The motor is located in front, and has either two or four cylinders, all being 100 mm. bore, and 140 mm. stroke; speed 950–1,400 r.p.m., giving 14 and 28 b.h.p. respectively. The larger size is illustrated by plan and elevation drawings of the car and photographs of the motor and change-speed gear. Throttle control and a centrifugal governor, maintaining the speed between 1,000 and 1,100 r.p.m., are provided, both of which act on the carburettor. The throttle can be applied by hand or

Digitized by Google

pedal independently, both when the governor is acting or cut out for accelerating the motor. The drive is by cone clutch to change-speed gear, giving three speeds and one reverse by spur gearing with side engagement, with direct drive on the high gear : from the gear box by bevel gear to the cross differential shaft and thence by chains to the road wheels. A compression-relieving device for starting is described. L. H. W.

753. *Brouhot Car.* **L. Fournier.** (Locomotion Automobile, 9. pp. 813–816, Dec. 18, 1902.)—A description of the general features of the Brouhot car [see Abstract No. 388 (1902)], showing the change in the transmission scheme made in the 1903 type, with illustration of the 20-h.p. size, including plan and elevation of the chassis. The transmission is much on Panhard lines ; the clutch is, however, here provided with an easily replaceable leather-coated steel ring forming the gripping surface. L. H. W.

754. *Motor Cars as Feeders to Railways.* **J. S. Montague.** (Automobile Club Journ. 5. pp. 184–187 ; Discussion, pp. 187–188, Feb. 19, 1903. Paper read before the Automobile Club, Feb. 13, 1902.)—The author advocates the establishment of regular services of motor cars for the collection of passengers in outlying residential districts in the vicinity of country and suburban railway stations, and also for the carriage of goods. Costs, actual and estimated, are discussed. A service is suggested for farm-to-farm collection of milk. The author suggests that, in place of costly tubes, or almost equally costly overhead lines, the London railway termini should be interconnected by motor omnibuses in the service of the companies concerned. G. W. DE T.

755. *Denis Steering Gear.* **G. Paillet.** (Locomotion Automobile, 10. pp. 136–137, Feb. 26, 1903.)—The Denis gear, made by Malicet and Blin, consists of a specially shaped cam operating the steering arm. It is claimed that this form of gear is irreversible for ordinary straight running, but, unlike the ordinary irreversible worm gear, allows of rapid and easy deflection of the wheels through large angles by the steering wheel. E. H. C.-H.

REFERENCES.

756. *Gridiron Slide Valves.* (Power, N.Y. 23. pp. 19–21, Jan., 1903.)—A description, with several drawings, of the gridiron valves used on the McIntosh and Seymour engine, and an account of the method adopted for setting them. H. R. C.

757. *Strength of Curved Stayed Surfaces.* **C. G. Robbins.** (Power, N.Y. 23. pp. 24–27, Jan., 1903.)—Two examples are worked out of the strength of vertical boilers having stayed cylindrical fire-boxes.

758. *Ejecto-condenser.* **A. Rateau.** (Génie Civil, 42. pp. 74–76, Nov. 29, 1902.)—A description of an ejecto-condenser with some novelty in the arrangement of the jet, and the results of some tests of the same. H. R. C.

759. *Comparative Economy of Stoking and Hand Firing.* **J. Geldard.** (Mech. Eng. 11. pp. 10–14, Jan. 3, 1903. Paper read before the Leeds Association of Engineers.)—This paper deals with evaporative tests made with a Lancashire boiler, 7 ft. 6 in. diameter by 26 ft. long, furnished with a Green's Economiser, and having a chimney 120 ft. high and 9½ sq. ft. internal area. The paper is chiefly valuable on account of the mass of observations recorded and the complete character of the illustrative charts of results. F. J. R.

Digitized by Google

INDUSTRIAL ELECTRO-CHEMISTRY AND GENERAL ELECTRICAL ENGINEERING.

760. *The "Max" Accumulator.* **J. J. Heilmann.** (Elektrochem. Zeitschr. 9. pp. 164–168, Dec., 1902.)—The electrodes are made of litharge; they are cylindrical, and built up as follows: The axis of the cylinder consists of a wire made of an alloy of antimony and lead, and the greater portion of this is surrounded by a compressed layer of litharge, about 8 mm. thick, and encased in a sheath of plaited asbestos. These electrodes can be made of any dimensions, and can be bent to any shape required. For ordinary purposes a number of them can be built together to form flat electrodes, the poles at either end being soldered to plates of the alloy of lead and antimony and the respective electrodes isolated from each other by means of ebonite; the accumulator can then be fitted up in the ordinary manner. The following advantages are claimed for the electrodes: the lead-antimony axis withstands the action of the electrolyte; for a given weight there is a very great superficial area; they are elastic, and will allow of usage which ordinary electrodes will not stand. After a time, the capacity of the accumulator is liable to decrease, but if the element is reversed, the original capacity is attained. Tables, from which the following is an extract, are given showing the efficiency of the various types:—

Type.	Approx. Weight.		Discharging Current (amps.).	Time of Discharge (hours).	Capacity (amp. hours).
	Electrodes.	Complete Element.			
C.	4 kg.	6·1 kg.	8	10	80
			14	5	70
			17	3	51

Taking the mean e.m.f. as 1·8–1·9 volts, the weight per h.p.-hour is 35–40 kg.

T. S. P.

761. *Output of Lead Storage-cells.* **A. L. Marsh.** (Elect. World and Engineer, 41. pp. 271–272, Feb. 14, 1903.)—This paper gives data relating to tests of an automobile cell, showing what percentage of the theoretical output of lead peroxide active material (101·8 a.h. per lb.) can be realised from cells designed for commercial purposes. There were 21 plates, all pasted. The 10 positives contained 100 oz. of lead peroxide, and the cell gave 11 amperes for 24 hours 45 min., or 272·25 a.h. down to 1·8 volts, and at an average p.d. of 2·07 volts. This represents 42·8 per cent. of ideal capacity, or 86 per cent. if Wade's hypothesis of a limiting sulphation of 50 per cent. is correct. The cell weighed 35 lbs., so its ampere-hour output per lb. of complete cell at a 25-hour rate was 7·8, and its watt-hour output 16·1. At a 4-hour discharge rate the cell gave 200 a.h., only 31·4 per cent. of ideal capacity.

E. J. W.

Digitized by Google

762. *Alloying of Metals as a Factor in Electroplating.* **L. Kahlenberg.** (Electrochem. Ind., Philadelphia, 1. pp. 201–202, Feb., 1903.)—In electroplating, the process of alloying always goes on to a greater or less extent, depending, primarily, on the nature of the metals, and, secondarily, on the conditions of the experiment. For example, when gold is plated on lead, an alloy of gold and lead is formed at the point of contact between the two metals; if the plating is thin, the gold will gradually sink into the base metal as the alloying process proceeds, even at room temperatures. A similar process goes on in the case of other alloys, and the "sinking in" of the alloy constitutes the "tarnishing" of the electroplated metal. Sometimes the deposit is of the same colour as the base metal underneath, *e.g.*, gold on brass, and then the effect of the diffusion of the metal into the other is not so apparent as when the metals are of a different hue. In some cases the colour of the alloy formed is the same as that of the plating, and this prevents the effect of diffusion being noticed, *e.g.*, nickel on copper. A high temperature often aids the alloying process, and frequently better adhering deposits are obtained by working at temperatures above the ordinary; often, however, alloys are readily formed by electrolysis at ordinary temperatures, whereas under ordinary conditions they would not be formed at all, or would form very slowly, *e.g.*, platinum amalgam. It follows that metals which will readily alloy with each other may in most cases be successfully plated on each other. The rate of absorption of the plating will depend on the character of the metals and the temperature at which they are kept. The formation of an alloy explains the fact that when lead is to be nickeled, it is first copper-plated and then the nickel is deposited on the copper. Copper alloys readily with nickel, and also alloys better with lead than does nickel; and so copper serves as a cement, as it were. Although strong alloying power between the base metal and the electrolytic deposit is desirable, it often militates against the object of the electroplating because of the "sinking in" of the metal deposited. T. S. P.

763. *Physical Character of Metal Deposits.* **C. F. Burgess** and **C. Hambuechen.** (Electrochem. Ind., Philadelphia, 1. pp. 204–207, Feb., 1903.)—The composition of the solution is the most important factor in determining the quality of a deposit, the addition of certain apparently foreign substances often having a marked effect; *e.g.*, the addition of carbon bisulphide to a silver-plating solution. Zimmerman, working in the authors' laboratory, has shown that different deposits of zinc are obtained according as the solution of zinc sulphate is made from crystals or by dissolving zinc in dilute sulphuric acid until a solution of the same composition is obtained as that prepared from the crystals. The theory of the alloying of the surface [see preceding Abstract] is not necessary to explain the tenacity with which one metal will adhere to another; *e.g.*, a good adherent deposit of nickel on iron is obtainable although there is no evidence of the formation of an alloy. The cohesion between the solid particles, as they are deposited, will account for all the phenomena observed. The more adherent coating obtained on a roughened than on a polished surface is due to the greater amount of actual surface per unit superficial area which is brought into contact. In using a solution from which an adherent coating is to be obtained, it is desirable that the solution should thoroughly "wet" the entire surface; the addition of extraneous substances to a solution may have this effect, and thus cause the better deposit. Reference is also made to the roughening, grooving, perforation, and peeling-off of electrolytic deposits, a series of characteristic photographs being given. T. S. P.

Digitized by Google

764. *Water-electrolyser of the Cologne Accumulator Works, System Schoop.* **G. Hagen.** (Centralblatt Accumulatoren, 4. pp. 37–39, Feb. 15, 1908.)—Sulphuric acid of maximum conductivity is electrolysed between lead electrodes at a p.d. of 8·3 to 8·6 volts per cell. A certain amount of lead peroxide is formed so that the lead electrodes act as a storage-battery of small capacity, and it is necessary to insert an automatic cut-out to prevent the reverse current flowing when the dynamo is stopped. The yield per h.p.-hour is 97·5 litres hydrogen (97·5 to 98 per cent. purity), and 48·75 litres oxygen (99·0 per cent. O_2, 0·80 per cent. H_2O, 0·20 per cent. H_2). The power-consumption is slightly higher than in other systems, but diaphragms are avoided, and the apparatus only needs attending to once a week to replace the water lost by evaporation. T. M. L.

765. *Purification of Water by Ozone at Wiesbaden and Paderborn.* **G. Erlwein.** (Zeitschr. Elektrochem. 8. pp. 881–887, Nov. 27, 1902.)—The Siemens-Halske plant at Wiesbaden has a maximum output of 60,000 gallons per hour, while the actual consumption is 33,000 gallons, so that an ample surplus is provided. Diagrams are given of the ozone generating apparatus and sections of the sterilising towers. The somewhat later installation at Paderborn is on a smaller scale, as it has to provide for only 13,000 to 15,000 gallons of sterilised water daily; the apparatus is the same, except that the outflow from the towers passes down a cascade of seven steps to get rid of the last traces of ozone. S. R.

766. *Electrical Process for Purifying Water.* (Electrochem. Ind., Philadelphia, 1. pp. 228–230, Feb., 1903.)—An illustrated description of an experimental plant based on the patents of C. C. Clark, which is said to be now in course of industrial application at several places. The water passes through a chamber with alternate positive and negative electrodes of copper and Acheson graphite, in the form of circular perforated plates, the voltage used being 240 direct-current. Arrangements for sedimentation and removal of *débris*, and tubes for either cooling or heating, occupy the body of the apparatus, which is similar in form to a locomotive. Another application claimed is for the purification and ageing of alcoholic beverages. S. R.

767. *Industrial Electrolysis of Water, and Autogenous Soldering by the Oxyhydrogen Blowpipe.* **F. Jottrand.** (Soc. Belge Élect., Bull. 19. pp. 719–733, Dec., 1902.)—According to the author, the electrolytic decomposition of water was first effected by Paets van Troostwyk in 1789, but it was not till about 1888 that Col. Renard, in France, and Latchinov, in Russia, introduced the first industrial apparatus for the production of oxygen and hydrogen by this method. The conditions of economy in e.m.f., free circulation of the liquid, and perfect separation of the gases are best fulfilled by the Garuti cell, as employed by the Société Anonyme l'Oxhydrique, founded at Brussels in 1896, which has since then been developing the commercial applications of oxygen and hydrogen under the author's direction, with the Garuti patents. The cell has metallic diaphragms, perforated with 1-mm. holes, and stopping short of the bottom; in this way there is free circulation of the liquid from end to end, while the gases do not pass through the holes but ascend and collect separately above. The compartments contain alternately anode and kathode plates. The anode compartments open at one end into a bell for the collection of the oxygen, and the kathodes open at the other end into another bell for the hydrogen. The whole is made of sheet iron, or, better, of soft steel

Digitized by Google

autogenously soldered, and is filled with 25 per cent. soda solution. The waste of the anodes does not exceed 15 per cent. of their weight in a year, and for the usual thickness of 0·7 mm. the life is three years. Three or 4 litres of water are added each day. The purity of the gases is continuously tested by Winssinger's densimeter, and also frequently examined by ammonio-cuprous chloride. The best conditions are a temperature of 15° to 20° C., and a voltage of 2·4, when the apparatus used furnishes 400 c.c. H and 200 c.c. O per ampere-hour, or 166·6 litres of H and 83·3 litres of O per kw.-hour. The author defends the priority of Garuti against the doubts of Engelhardt in his *Elektrolyse des Wassers*, 1902. In the blowpipe used by the author the tubes conveying the oxygen and hydrogen at the same pressure join just before entering the wide end of a cone in which they mix. It is stated that there is no danger of the flame passing backwards with the arrangements described for regulating the velocity. When hydrogen or coal gas at a less pressure has to be employed the oxygen enters by an injector jet. In soldering iron or steel oxidation of the metal is completely avoided, and a suitable temperature is obtained by using 4 volumes of H to 1 of O. With these blowpipes the piercing or cutting of metals, the filling of holes, and the autogenous soldering even of thin sheets can be accomplished cleanly and with great ease, while the joints have the minimum of electrical resistance and the maximum of strength. The author suggests the joining in this way of the rails of electric railways or trams, without any boring or special cleaning, by copper or iron threads. Another application is the fusing together of small rubies or emeralds to make bearings and pivots. S. R.

768. *High-Temperature Electro-Chemistry: Experimental and Technical Electric Furnaces.* **R. S. Hutton** and **J. E. Petavel.** (Inst. Elect. Engin., Journ. 32. pp. 222–247, Feb., 1903.)—A full description, with diagrams, is given of the generating plant and furnaces installed in the electro-chemical laboratory of Owen's College, as indicating the general equipment necessary in a laboratory for effective experimental work in this subject. The present position of the industries involving fusion by the electric furnace, or fusion and electrolysis, is shown; recent advances being pointed out, and directions suggested in which improvements are to be expected. For calcium-carbide production, the authors consider an alternating current most suitable, being more easily transmitted to a distance and better able to withstand variations in load, whilst the carbide produced is more uniform in quality. Besides acetylene generation, other uses for carbide are as a metallurgical reducing agent, and for production of finest grade lamp-black. Silicon, now produced in considerable quantities by Scheid's process, seems likely to displace its alloys in castings, while ferro-titanium and ferro-vanadium will probably be more widely used technically. Details are given of the graphitisation of anthracite, by which granular graphite, a valuable lubricant, is obtained. In the electrolysis of fused salt, using fused lead as kathode, success depends on the rapid removal of the sodium alloy formed. Acker secures this with a steam injector, driving the lead past the anodes, and oxidising the sodium. The production of nitric acid from air is stated to have given very promising results experimentally, and steps are being taken to start it on a commercial scale. W. H. S.

769. *Smelting of Iron Ores and Production of Steel in the Electric Furnace.* **M. Ruthenburg.** (Electrochem. Ind., Philadelphia, 1. pp. 202–208, Feb., 1903.)—The method used by the author consists in

Digitized by Google

holding the ore (a small portion at a time) in the electric furnace by means of a powerful magnet. Only the portion held by the magnet is melted, the ore supply from above resting on the magnetic bridge and being thereby restrained from slipping through. The poles of the magnetic circuit are also the poles of the melting circuit. As soon as the ore is fused, it drops out of the zone of fusion, and its place is taken by more ore from above. Before being put into the furnace, the ores are cleaned and then mixed to produce the desired chemical composition of the finished material, the required reducing material being also added. Less than 500 kw.-hours are required to produce a ton of the product, and ordinary cheap coal can be used instead of coke. [See also Abstract No. 1899 (1902).] T. S. P.

770. *Testing Supply Meters on Consumers' Premises.* **W. J. Mowbray.** (Elect. World and Engineer, 41. pp. 475–477, March 21, 1903.)—The author uses a portable test meter. This is constructed on the same lines as a Thomson recording wattmeter, but differs from it in the following respects: (1) The field has three separate windings which can be readily coupled up to give full field with either 10, 20, or 100 per cent. of full current. (2) There are two shunt circuits for 115 and 230 volts respectively. (3) No recording train is used, an even number of revolutions being counted on the brake disc by the tester's assistant, while the tester himself notes the corresponding revolutions on the consumer's meter; the latter is fitted with a special scale to enable fractions of a revolution to be accurately measured. It is claimed that by running the portable meter at full torque for all readings, frictional errors are obviated. The advantages put forward are low first cost and maintenance, accuracy, quickness, and simplicity in testing. To avoid temperature errors, double voltage is applied to the shunt coil for one and a half minutes before the first reading, so as to warm the parts up to their working limits. The instrument can be used with but slight error on non-inductive alternating circuits. H. F. H.

771. *Modern Turbine Practice and the Development of Water Powers.* **J. W. Thurso.** (Eng. News, 49. pp. 26–30, Jan. 8, 1903.)—This is a continuation of the article dealt with in Abstract No. 470 (1903). When turbines subject to considerable load fluctuations are supplied by penstocks of great length in proportion to the head, no governor can give good regulation, and the author, in such cases, advocates the use of a relief valve consisting of a large open stand-pipe with its top slightly above the high-water level in the headrace. With high heads, when a stand-pipe would be prohibitively expensive, and ineffective on account of the inertia of the water-column, fly-wheels are advised, in accordance with general European practice. Armatures of large flywheel capacity, as used at Niagara, obviate the use of separate flywheels. Where economy in water is no object, a by-pass regulation is advisable, and admits of the closest regulation, besides preventing shocks to the penstocks, without the use of air chambers. Regulation by throttling is strongly deprecated on account of its wastefulness. The construction of water racks and their equivalents, the principles of penstock design, and the conditions governing the rate of flow allowable in the penstocks, are discussed. Draught tubes are strongly advocated, but the present practice of making their cross-section uniform is condemned. They should be tapered, so as to give a gradual change in the speed of the water. It is often advisable to incline the draught tube, so as to give sufficient length to duly reduce the speed of the water issuing from the runner. At the

Digitized by Google

conclusion of the paper some useful suggestions are made with a view to promoting a uniform nomenclature for hydraulic engineering.

G. W. DE T.

772. *Limits in Heavy Electrical Engineering.* **J. Swinburne.** (Inst. Elect. Engin., Journ. 32. pp. 9–48, Feb., 1903. Inaugural presidential address.)—The author first deals with the relations between pure and applied science. He next points out that tidal water power is too costly for practical utilisation, and that far too much importance has been attributed to the advantages even of cheap water power, to the neglect of such equally, or more, important factors in commercial manufacture as cost of labour and of carriage. He then refers to numerous problems, of interest to the electrical engineer, indicating various directions in which research may be expected to be practically fruitful, and others in which this is not to be anticipated. Attention is called to the want of a variable speed-gear for electric cars, and one devised by Hall for automobiles is described in a note. It consists of two sets of oil pump engines of variable stroke mounted in a rotating frame. One set works on to a fixed axle, the other on to the driving axle, while the frame is rotated by the motor. G. W. DE T.

773. *Electric Crane.* (Engineering, 75. pp. 146–148, Jan. 30, 1903.)—This article describes the details, without drawings, of a 50-ton electric crane, erected in a shipbuilding yard at Hamburg. It is worked by three independent series-wound motors, viz., a 50-h.p. motor for hoisting, one of 30 h.p. for slewing, and one of 35 h.p. for altering the jib angle. A load of 50 tons can be raised at the rate of 7 ft. per minute at a radius of 62 ft., the crane itself being of the portal type. W. H. S.

774. *Power Required to drive Machine Tools.* (Elect. Rev. N.Y. 42. pp. 233–236, Feb. 14, 1903.)—This article gives the results of tests carried out by the Westinghouse Company at the railway shops of the Buffalo, Rochester and Pittsburg Railway. A large number of figures are given, showing the power taken by the shafting and by various machines. The following are quoted as examples of the figures given in the article: A line of shafting 170 ft. long, $2\frac{1}{2}$ in. in diameter, with 19 hangers, took 0·8 h.p. when running at 158 r.p.m. When the countershafting was added to this, the power required was on an average 2 h.p. A small group of machines took on an average 1 h.p., with a minimum of 0·2 h.p. and a maximum of 3·5 h.p. A shearing machine took 6·9 h.p. when started light, 0·4 h.p. when once started, and 3 h.p. when shearing $\frac{5}{16}$ in. steel plate. W. H. S.

775. *Electrical River Gauge.* **J. F. Barnes.** (Elect. Rev. N.Y. 42. p. 228, Feb. 14, 1903.)—A device is here described which was invented by W. M. Fulton and is used by the American Government for observing the rise and fall of river levels. The motion of a float is utilised to cause intermittent contacts in mercury cups. These contacts bring relays into action, and the pen is shifted along the axis of a recording drum by means of pawls, ratchets, and grooved shaft. W. H. S.

REFERENCE.

776. *Ozone Waterworks at Wiesbaden and Paderborn.* (Scientific American, 88. pp. 132–133, Feb. 21, 1903.)—An illustrated account of the ozonisers, high potential transformers, and sterilising towers used in these works. [See Abstract No. 765 (1903).] S. R.

Digitized by Google

GENERATORS, MOTORS, AND TRANSFORMERS.

777. *Self-excitation of Dynamos.* **L. Finzi.** (Phys. Zeitschr. 4. pp. 212–217, Jan. 1, and pp. 241–247, Jan. 15, 1903.)—The researches described relate to the connection which exists between the time taken by a self-exciting machine to build up its field, on the one hand, and the resistance of the exciting circuit, the speed at which the machine is driven, and the value of the residual magnetism on the other. This time was found to increase with the resistance of the exciting circuit (the time-voltage curve closely resembles the magnetisation curve), and to decrease with increase of speed. The residual magnetism affects only the early portion of the time-voltage curve, the initial rise of voltage being greatly prolonged by a weakening of the residual magnetism; the upper part of the curve is not affected. The author attempts to deal with the matter theoretically, by assuming a constant value for the permeability, so as to arrive at results which hold only for the straight-line portion of the B-H curve; the results he finds not to be in agreement with experiment, and attributes the discrepancy to magnetic time-lag and the retarding effect of eddy-currents in solid cores. A. H.

778. *Reducing Armature Reaction.* **A. Spilberg.** (Électricien, 25. pp. 168–173, March 14, 1903.)—The author proposes to divide each set of brushes into two parts, setting half the brushes two or three sections ahead of the neutral line and the other half an equal distance behind, the two halves being connected together to form one set of brushes. If they are suitably adjusted no current will flow from the forward brushes to the backward one or *vice versâ*. The armature sections which are between the forward and backward brushes being out of the circuit, the back ampere-turns can be reduced or suppressed altogether, and the cross magnetising turns reduced; and as the e.m.f. produced in these sections is very small the voltage of the machine is not reduced much. A further gain is that the effective resistance of the armature is reduced.
R. B. R.

779. *Rise in Pressure on a Three-phase Generator.* **F. Finckl.** (Elektrotechn. Zeitschr. 24. pp. 198–199, March 12, 1903.)—The machine was of 1,000-kw. capacity, supplying at 2,000 volts a H.T. feeder system, and had for years worked faultlessly alone and in parallel until the mica insulation of a certain armature coil was burnt by a fault to the iron core, accompanied by the appearance of a stratic discharge between the core and the outer part of the coil, denoting the presence of unusually high pressures. Investigation showed that at the time a variable "earth" had occurred in the H.T. feeders. The particular machine was noticed to have the property of giving powerful shocks to persons touching the iron core of the stator, leading to the conjecture that all the above peculiarities were interconnected. On the one hand the earth on the feeder (one conductor) upset the symmetry of the three-phase terminal pressures with regard to "earth" and induced in the machine a charging current between the iron-core and earth, while, on the other hand, it was evident from the shocks obtainable that the iron core was insulated, though not purposely, from the frame. It follows that

Digitized by Google

in this machine the earth-charging current had to pass through a layer of dielectric or insulation between the core and the frame, which it doubtless did by a static discharge. In the author's experience the usual practical values of frequency, cable capacity, &c., do not lend themselves to the production of resonance effects, and he attributes the breakdown to the presence of high frequency currents of small wave-length, caused by static discharges from core to frame. The discharge must not be confused with arcing proper. To prove his theory, he ran the machine up, and then artificially earthed one pole, when the phenomenon immediately occurred, but disappeared when the iron core was connected to the frame. The last device turned out to be a permanent cure. R. C. R.

780. *Compounding Alternators.* **Boy de la Tour.** (Ind. Élect. 12. pp. 101–105, March 10, 1903.)—The author points out graphically some of the difficulties which have to be overcome in compounding alternators so as to give a constant p.d. at all loads and power factors. He considers that a perfect solution is theoretically impossible, although approximate solutions have been found which are useful in practice. Vectorial diagrams are not permissible when we are considering machines with polar projections. In his opinion the necessity for using compounded alternators only arises when the ratio of the variations of the load on a machine to the total load is large. If the load is a non-inductive one, the problem is very similar to that of compounding a direct-current dynamo, but if the load be inductive, the problem is exceedingly complex. A. R.

781. *Compounded and Compensated Asynchronous Alternating-current Machines.* **A. Heyland.** (Elektrotechn. Zeitschr. 24. pp. 51–54, Jan. 22; 72–75, Jan. 29; and pp. 95–97, Feb. 5, 1903.)—A description of Heyland's method of compensating alternators was given in a former paper. [See Abstract No. 2828 (1902).] Several of these machines have now been made by different firms, and the present papers give a description of the latest improvements in the windings and other details. The compensated asynchronous motor bears to the ordinary short-circuited motor the same relationship that a synchronous motor with separate excitation bears to the same motor excited by induction from the armature. In the compensated motor, the field is excited in the rotor by currents from the supply mains, introduced through brushes bearing on a commutator, so that the currents produce in the rotor a field rotating at the speed of the slip, and therefore synchronous with the armature field. The compensation modifies the magnetic and electrical conditions and affects the design. Machines become broader and of smaller diameter than ordinary asynchronous ones, leakage is less, and the slotting becomes simpler, there being fewer slots per pole, and the slots can be made open, so that former-wound coils may be used. The magnetising ampere-turns are removed by compensation from the stator to the rotor, so that the slots in the former become smaller and in the latter larger. The rotor has usually a smaller number of large slots. In the ordinary motor the rotor field = stator field − leakage, and the overload capacity is limited by the increasing leakage. In the compensated motor the rotor field = stator field + leakage, consequently the overload capacity is much greater and is determined by other points than the leakage. If the air-gap is increased, the leakage is increased, and the rotor field has to be increased, but there is no objection to increasing it, as the frequency is low and no great iron loss is involved. The normal output

Digitized by Google

of the machines increases proportionally to the winding space, and this can be increased by deepening the slots in a compensated machine. The commutator required has only 5 to 10 per cent. of the surface of the commutator of a continuous-current machine of the same power. Three brushes are required for compensating and three for compounding, but in one arrangement of compounding only three brushes are required altogether. Three segments per pole are usual in compensated and six segments per pole in compounded machines. The winding of the rotor was at first of the drum armature type, and the commutator segments were short-circuited by resistance strips. Now a double three-phase winding is used, and the short-circuiting of the commutator segments is unnecessary or, if employed, the short-circuiting strips can be of much higher resistance than formerly, and fewer of them are required. The paper gives full details of the winding with diagrams. The pulsations in the rotor currents, due to commutation, are consumed in the windings themselves by having two coils in each slot, one belonging to the first three-phase winding and the other to the second, and the windings are connected to the commutator, so that at least one set is always in contact with the brushes. The mutual induction of the coils enables the current fluctuations due to commutation in one winding to be transferred to the other closed winding and not expended in sparking at the brushes. The theory of the commutation is clearly shown by diagrams. In some cases four three-phase windings are wound side by side in the same slots. Two of them are then connected up in star and two in delta. The author considers the application of these devices to large slow-running machines which it is so difficult to parallel, and shows that they are equally applicable to this type. J. B. H.

782. *Heyland's Induction Motor.* **Boy de la Tour.** (Elect. World and Engineer, 41. pp. 442–448, March 14, and pp. 479–480, March 21, 1903.)—The author gives a graphical treatment of the problem of the Heyland induction motor and briefly discusses its relative advantages and disadvantages. He inclines to the view that the increase in the power-factor is obtained at the cost of too great a complication in the construction of the motor. A. H.

783. *Testing Induction Motors.* **Larmoyer.** (Assoc. Ing. Él. Liége, Bull. 8. pp. 29–41, Feb., 1903.)—A complete account is given of a test on a 82-h.p. three-phase induction motor. Heyland's circle diagram is constructed from the requisite experimental data and the efficiency is calculated from it. The efficiency is then calculated by a method analogous to Swinburne's method for direct-current motors. The formula used is—

$$\eta = (1 - \gamma)(P - P_1 - P_2)/P,$$

where η is the efficiency, γ the slip, P the power given to the machine, P_1 the power lost at synchronous speed by hysteresis, eddies and friction, and P_2 is the loss in heating the conductors of the stator. The results show a satisfactory agreement. A. R.

784. *Rotary Magnetic Fields.* **Noaillon.** (Assoc. Ing. Él. Liége, Bull. 8. pp. 42–71, Feb., 1903.)—The author discusses the rotating fields in the air gap of induction motors. He assumes that the currents follow the harmonic law and considers two-phase and three-phase lap and wave windings. The magnetic field in the gap at any instant is not sine shaped, but depends

Digitized by Google

on the winding and the number of slots. This field may be supposed to be built up of a number of sine-shaped fields. [See also M. B. Field, Elect. Rev. 44. pp. 194, &c.] The first space harmonic produces a field rotating with angular velocity $+\omega$. The third harmonic has no effect in a three-phase machine. The harmonics of order $6n-1$ and $6n+1$ respectively produce fields rotating with velocities $-\frac{\omega}{6n-1}$ and $+\frac{\omega}{6n+1}$. He finds the amplitudes of these harmonics for lap and wave windings, and by assuming the permeability of the iron to be infinite he arrives at very simple formulæ, some of which verify those arrived at graphically by Boy de la Tour. Formulæ are found for the back e.m.f. induced in a three-phase stator traversed by an harmonic current when the circuit of the rotor is open. It is shown that for a lap winding the maximum value of the induction density is greater than that generally assumed, so that the hysteresis loss may be considerably greater than that found by the ordinary calculation. On the other hand, with a wave winding, the hysteresis loss will be less.

A. R.

785. *Transformer Regulation.* **G. Grassi.** (Atti del' Assoc. Elettr. Ital. 7. pp. 1–6, Feb., 1903.)—The formula for the drop of secondary voltage of a transformer with varying inductance in the secondary circuit given by the author in the Rendiconti della R. Accademia delle Scienze Fisiche e Matematiche di Napoli, in part iii., 1902, may be expanded into an expression consisting of a constant and two periodic terms, of which the first has twice the period and much greater amplitude. A fair approximation is given by taking the first only, when the secondary drop may be represented by a sine curve by suitable choice of axes. A. E. L.

REFERENCES.

786. *Design of Electrical Machinery.* **H. M. Hobart.** (Elect. Rev. 51. pp. 928–930, Dec. 5, and pp. 975–978, Dec. 12, 1902.)—The author here gives a series of very elaborate specification forms which he employs in designing electrical machinery. Their use is illustrated by filling in the forms with the details relating to the design of a rotary converter. He strongly advocates the keeping of as complete a record as possible of the electrical and magnetic data of all machines designed. The filing of such specifications will greatly facilitate the making of modifications to meet special conditions. G. W. DE T.

787. *Heating of Electric Machines.* **W. Schüppel.** (Zeitschr. Elektrotechn., Wien, 21. pp. 77–83, Feb. 8, 1903.)—An account of experiments undertaken to investigate the effects of the nature of the radiating surface (whether painted or not), the fanning action due to rotation, and the effect of load, on the temperature rise of two types of machine. A. H.

788. *Starting Continuous-Current Motors.* **L. Brunhes.** (Assoc. Ing. Él. Liége, Bull. 2. pp. 214–268, March–April, May, and pp. 466–517, July, Aug., Sept., and Oct., 1902.)—A mathematical discussion of questions connected with the starting of motors. W. H. S.

789. *Circle Diagram of Induction Motor.* **J. K. Sumec.** (Zeitschr. Elektrotechn., Wien, 21. pp. 1–5, Jan. 4, 1903.)—The author extends the circle diagram of the induction motor to include the resistance and hysteresis losses in the primary, and deduces a number of formulæ from the modified diagram [see also Abstract No. 1592 (1901)]. A. H.

Digitized by Google

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

790. *Sag in Overhead Conductors.* **K. Otto.** (Elektrotechn. Zeitschr. 24. pp. 87–88, Jan. 15, 1903.)—Formulæ are deduced by the author for calculating the sag of an overhead wire, under given conditions of temperature and wind-pressure, from the original length of wire. These formulæ are utilised for the construction of curves by means of which it is easy to determine the tension at which the wire should be erected at a given temperature in order that the maximum safe stress corresponding to given limits of temperature and wind-pressure may not be exceeded. A. H.

791. *Standardisation of Cables.* (Mech. Eng. 11. pp. 249-250, Feb. 21, 1903.)

TABLE I.

THE STANDARD SIZES OF CONDUCTORS ADOPTED FOR ELECTRIC SUPPLY MAINS ARE—

Nominal area of conductors in square inches.	No. and diameter of strands.	Resistance in standard ohms per 1,000 yards at 60° Fahr.			Weight in lbs. per 1,000 yards.	
		Calculated.	Maximum allowable.	Maximum allowable for tinned wires.	Calculated.	Minimum allowable.
0·025	7/·068	0·963	0·982	0·992	300·	294·
0·050	7/·095	0·493	0·502	0·507	580·	568·
0·050	19/·058	0·488	0·498	0·503	591·	580·
0·075	19/·072	0·325	0·331	0·334	913·	896·
0·100	19/·082	0·244	0·249	0·252	1182·	1158·
0·125	19/·092	0·194	0·198	0·200	1488·	1458·
0·150	19/·101	0·160	0·163	0·165	1781·	1745·
0·150	37/·072	0·163	0·166	0·168	1776·	1740·
0·200	37/·082	0·125	0·128	0·129	2303·	2257·
0·250	37/·092	0·0997	0·102	0·103	2900·	2842·
0·300	37/·101	0·0827	0·0843	0·0852	3494·	3424·
0·350	37/·110	0·0697	0·0711	0·0715	4145·	4062·
0·400	37/·118	0·0606	0·0618	0·0621	4772·	4677·
0·400	61/·092	0·0605	0·0617	0·0623	4781·	4685·
0·500	61/·101	0·0502	0·0512	0·0517	5762·	5647·
0·600	61/·110	0·0423	0·0431	0·0433	6836·	6699·
0·600	91/·092	0·0405	0·0413	0·0417	7134·	6991·
0·700	91/·098	0·0357	0·0364	0·0368	8094·	7932·
0·750	91/·101	0·0336	0·0343	0·0346	8597·	8425·
0·800	91/·104	0·0317	0·0323	0·0327	9115·	8933·
0·900	91/·110	0·0283	0·0289	0·0290	10200·	9996·
1·000	91/·118	0·0246	0·0251	0·0252	11740·	11510·
1·000	127/·101	0·0241	0·0246	0·0248	11910·	11672·

Digitized by Google

TABLE II.

THE STANDARD RADIAL THICKNESSES OF DIELECTRIC, LEAD, AND ARMOUR FOR UNDERGROUND MAINS.

Nominal area of conductors.	High-tension Three-Core. Working Pressure.			Extra High-Tension Three-core. Working Pressure.								
	2,000 volts.			3,000 volts.			6,000 volts.			10,000 volts.		
	Dielectric between and outside.	Dielectric outer on star winding with centre earthed.	Lead.	Dielectric between and outside.	Dielectric outer on star winding with centre earthed.	Lead.	Dielectric between and outside.	Dielectric outer on star winding with centre earthed.	Lead.	Dielectric between and outside.	Dielectric outer on star winding with centre earthed.	Lead.
sq. in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
0·025	0·13	0·10	0·08	0·15	0·12	0·09	0·23	0·17	0·10	0·35	0·23	0·12
0·050	0·13	0·10	0·09	0·15	0·12	0·10	0·23	0·17	0·11	0·35	0·23	0·13
0·075	0·13	0·10	0·10	0·15	0·12	0·10	0·23	0·17	0·12	0·35	0·23	0·13
0·100	0·14	0·11	0·11	0·16	0·13	0·11	0·24	0·18	0·12	0·36	0·24	0·14
0·125	0·14	0·11	0·11	0·16	0·13	0·12	0·24	0·18	0·13	0·36	0·24	0·14
0·150	0·14	0·11	0·12	0·16	0·13	0·12	0·24	0·18	0·13	0·36	0·24	0·15
0·200	0·14	0·11	0·13	0·16	0·13	0·13	0·24	0·18	0·14	0·36	0·24	0·16
0·250	0·15	0·12	0·13	0·17	0·14	0·14	0·25	0·19	0·15	0·37	0·25	0·17

Nominal area of conductors.	High-Tension Concentric.			Extra High-Tension Concentric.								
	Dielectric inner.	Dielectric earthed outer.	Lead.	Dielectric inner.	Dielectric earthed outer.	Lead.	Dielectric inner.	Dielectric earthed outer.	Lead.	Dielectric inner.	Dielectric earthed outer.	Lead.
sq. in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
0·025	0·12	0·08	0·08	0·15	0·09	0·09	0·23	0·10	0·10	0·35	0·12	0·12
0·050	0·12	0·08	0·09	0·15	0·09	0·10	0·23	0·10	0·11	0·35	0·12	0·13
0·075	0·12	0·08	0·09	0·15	0·09	0·10	0·23	0·10	0·12	0·35	0·12	0·14
0·100	0·13	0·09	0·10	0·16	0·10	0·10	0·24	0·11	0·12	0·36	0·12	0·14
0·125	0·13	0·09	0·10	0·16	0·10	0·11	0·24	0·11	0·13	0·36	0·12	0·14
0·150	0·13	0·09	0·11	0·16	0·11	0·11	0·24	0·12	0·13	0·36	0·12	0·15
0·200	0·13	0·09	0·11	0·16	0·11	0·12	0·24	0·12	0·13	0·36	0·12	0·15
0·250	0·14	0·10	0·12	0·17	0·11	0·13	0·25	0·12	0·14	0·37	0·12	0·16

Digitized by Google

STANDARD RADIAL THICKNESSES OF DIELECTRIC, LEAD, AND ARMOUR FOR UNDERGROUND MAINS :—

Low tension up to 500 volts working pressure.

Test at works for	Test when laid and jointed.
Paper, 2,500 v. for 15 mins.....	1,000 volts for 1 hour.
Jute, 1,500 „ „	1,000 „ „

Twin cables shall have the same thickness as three-core.

Nominal area of conductors.	Single.		Concentric.			Triple Concentric.				Three-core.	
	Dielectric.	Lead.	Inner dielectric.	Outer dielectric.	Lead.	Inner dielectric.	Intermediate dielectric.	Outer dielectric.	Lead.	Dielectric between conductors, and from conductors to lead.	Lead.
sq. in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
0·025	0·08	0·06	0·08	0·08	0·07	0·08	0·08	0·08	0·08	0·09	0·08
0·050	0·08	0·06	0·08	0·08	0·08	0·08	0·08	0·08	0·09	0·09	0·09
0·075	0·08	0·07	0·08	0·08	0·08	0·08	0·08	0·08	0·10	0·09	0·10
0·100	0·09	0·07	0·09	0·09	0·09	0·09	0·09	0·09	0·10	0·10	0·10
0·125	0·09	0·07	0·09	0·09	0·09	0·09	0·09	0·09	0·11	0·10	0·11
0·150	0·09	0·08	0·09	0·09	0·10	0·09	0·09	0·09	0·11	0·10	0·11
0·200	0·09	0·08	0·09	0·09	0·10	0·09	0·09	0·09	0·12	0·10	0·12
0·250	0·10	0·09	0·10	0·10	0·11	0·10	0·10	0·10	0·13	0·11	0·13
0·300	0·10	0·09	0·10	0·10	0·11	0·10	0·10	0·10	0·13	0·11	0·13
0·350	0·10	0·09	0·10	0·10	0·12	0·10	0·10	0·10	0·14	0·11	0·14
0·400	0·10	0·10	0·10	0·10	0·12	0·10	0·10	0·10	0·14	0·11	0·14
0·500	0·10	0·10	0·10	0·10	0·13	0·10	0·10	0·10	0·15	0·11	0·15
0·600	0·11	0·11	0·11	0·11	0·13	...	...	...	...	...	...
0·700	0·11	0·11	0·11	0·11	0·14	...	...	...	...	...	...
0·750	0·11	0·11	0·11	0·11	0·14	...	...	...	...	...	...
0·800	0·12	0·12	0·12	0·12	0·15	...	...	...	...	...	...
0·900	0·12	0·12	0·12	0·12	0·15	...	...	...	...	...	...
1·000	0·13	0·12	0·13	0·13	0·15	...	...	...	...	...	...

The pressure tests of the above cables to be :—

Working pressure.	Test at Works.	Test when Laid and Jointed.
2,000 volts	10,000 volts for 15 mins.	4,000 volts for 1 hour.
3,000 „	12,000 „ „	6,000 „ „
6,000 „	20,000 „ „	12,000 „ „
10,000 „	30,000 „ „	20,000 „ „

The above dielectrics are safe for use at pressures 10 per cent. above their standards. The dielectric and lead on all conductors, whether mains or pilot wires, smaller than 0·025 shall have the thicknesses given for 0·025. All intermediate sizes shall have the thicknesses given for the next larger size on the list. The allowable variation in radial thicknesses of dielectric and lead at any point is 10 per cent. below the standard minimum thicknesses given in the table, but the mean of the thicknesses shall be at least that specified. The standards for armouring are as follows : For cables below 0·50 in. diameter over lead, by galvanised steel wires 0·072 in. diameter. For cables

Digitized by Google

from 0·50 in. to 0·75 in. over lead, by two layers of compounded steel tape, each 0·030 in. thick. For cables from 0·76 in. to 2 in. diameter, by two layers of compounded steel tape, each 0·060 in. thick. The standard thicknesses of jute serving, when applied to diameters less than 0·50 in., to be 0·06 in., and for larger diameters 0·10 in. M. O'G.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

792. *Eastbourne Electricity Works.* (Elect. Engin. 31. pp. 330–339, March 6, 1903.)—*System:* Alternating current generated at 2,200 volts, 50 cycles per sec., and distributed at 200 volts. The *boiler-room* contains two Hornsby water-tube boilers, an Economic boiler, two Stirling boilers—the latter capable of evaporating 10,000 lbs. of water each per hour, and fitted with McPhail and Simpson superheaters—and a Babcock boiler, having a heating surface of 2,255 sq. ft., and fitted with a superheater. The boilers work at 140 lbs. per sq. in. Steam-driven feed-pumps of various makes are provided. The feed-water is heated by a Warwick detartariser to 212° F.; there is also an economiser. Coal is stored in bunkers capable of holding 120 tons, and is fired by hand. The *engine-room* contains two Ferranti steam alternators, each consisting of a vertical compound engine, having cylinders 20 and 36 in. in diameter and stroke 15 in., coupled to a single-phase alternator of 400 kw., and running at 250 r.p.m.; one Willans engine driving an E.C.C. alternator of 200 kw.; one Davey-Paxman engine coupled to an E.C.C. alternator of 150 kw.; and one Willans-E.C.C. set of 50 kw. Each alternator is provided with its own exciter. The switch-gear is of the Ferranti cellular type. Four feeders of Glover's diatrine lead-covered type, of 0·12 sq. in. cross-section, concentric, convey the high-pressure current to 7 substations; from the latter the distributors are laid, forming a low-pressure network. The transformers are of the Berry type. The streets are lighted with Gilbert arc lamps, run 17 in series from constant-current transformers; there are also 66 arc lamps supplied through transformers from the low-pressure mains. The equivalent of 55,000 8-c.p. lamps is connected. The price charged is 6½d. per unit for lighting and 3d. per unit for power at uniform rates. The article is fully illustrated. A. H. A.

793. *Trafford Park Power Station.* (Electrician, 50. pp. 849–851, March 13, and pp. 888–890, March 20, 1903.)—Particulars of the original plant were given in Abstract No. 1424 (1901). A double-current A.E.G. generator has been added, giving 660 kw. at 180 r.p.m.; this is driven by a Browett-Lindley vertical two-crank compound engine, with cylinders 20 and 40 in. in diameter and 22-in. stroke. Direct-current is generated at 500–550 volts, and three-phase current at 340 volts, 30 $\sim$. The switchboard has also been largely extended. A special feeder has been laid along the Manchester Ship Canal to supply the docks and warehouses; 22 electric cranes are in use on the direct-current mains. Power is supplied in bulk to the Sale Urban District Council, 3 to 4 miles distant, by transforming up the three-phase current to 3,000 volts for transmission to 2 motor-generators at Sale, which generate direct current at 235–250 volts. There is also a motor generator at the power-station, receiving direct current and giving alternating current at 3,000 volts and the same frequency as the double-current generator. The article is illustrated with photographs and drawings. A. H. A.

Digitized by Google

794. *Colorado Springs Power Plant.* **J. H. Rusby.** (Elect. Rev. N.Y. 42. pp. 406–409, March 21, 1903.)—*System:* Energy is transmitted 6 miles at 6,600 volts three-phase from Austin Bluffs to Colorado Springs. The *boiler-room* contains five Aultman-Taylor (Cahall) boilers of 400 h.p. each, and two Babcock boilers of 500 h.p., each working at 160 lbs. per sq. in. The chimney is of steel, 9 ft. 6 in. in diameter inside and 170 ft. high, including the pedestal. The feed-water is heated by exhaust steam to 198° F. Coal is derived from an adjacent mine by a gravity railway, and is fired by hand. The *engine-room* contains three International Power Company's engines of the horizontal compound non-condensing type, with cylinders 24 and 44-in. diameter by 48-in. stroke, giving 1,500 i.h.p. each at 90 r.p.m. Each engine drives directly a 750-kw. three-phase 6,600-volt "G. E." alternator, provided with a flywheel weighing 70,000 lbs., and 20 ft. in diameter. There are also two 50-kw. exciters of the same make, driven by high-speed engines, and two 15-kw. two-pole dynamos, belted to a "G. E." induction motor as stand-by. An automatic regulator controls the supply voltage. The transmission system is in the form of a triangle, with the two substations connected together—15 miles of line in all. The line consists of two sets of three No. 1 B. & S. gauge copper wires, carried by triple-petticoat insulators on cedar poles 100 ft. apart. At Colorado Springs the pressure is transformed to 2,800-volts two-phase, with single-phase distribution. A steam engine driving one 150-kw. and two 75-kw. dynamos is provided at one of the substations, with a 150-kw. transformer. The secondary system is to be changed from two-phase to three-phase. A number of enclosed arc lamps are in use. Each of the local ore reduction mills has its own substation, where the pressure is reduced to 460 volts three-phase for distribution. The load-factor is 52·6 per cent. The Manitou Electric Company receives energy for lighting and power in Manitou, where many enclosed arc and incandescent lamps are used. A. H. A.

795. *Electric Power Station in Butte County, California.* (Journal of Electricity, S.F. 18. pp. 170–176, March, 1903.)—The Butte County Electric Power Company was formed in 1898 for the purpose of developing the water power of Butte Creek, a station being built at a point about 14 miles from the town of Chico to supply current to that place and other points round about. Water is taken from the creek about 8 miles from the power-house and carried, partly by canal and partly (about 1¼ miles) by flume, so as to give a static head of practically 600 ft. at the power-house. The penstock is at an elevation of 1,600 ft. above sea-level, and a 24-in. pipe is laid therefrom to the power-house, which was originally equipped with two sets of single Pelton water-wheels, each of 58-in. diameter and running at 400 r.p.m. Each wheel consists of a disc centre with cast steel buckets mounted on a hammered steel shaft. The water impinges on the wheels by means of deflecting single nozzles, controlled electrically by Pelton governors, while directly behind the deflecting nozzles are gate valves of the Pelton single-disc type with outside yokes, screws, and rising spindles. The shafts are supported by automatic ring oiling pedestals of the standard Pelton type; the wheels are completely enclosed in upper and lower steel cases, the whole being mounted on heavy cast-iron floor plates let into masonry foundations. By means of flexible leather link flywheel couplings, each weighing 5,000 lbs., each wheel is coupled direct to a 400-kw. Westinghouse three-phase generator, connected star fashion, delivering current at 2,400 volts, 60 cycles, to a bank of three 150-kw. oil-insulated air-cooled transformers, by which the pressure is

Digitized by Google

raised for transmission purposes to 16,500 volts. A fourth transformer of similar type and capacity is kept in reserve. The neutral wire is earthed. The exciters, each of 75-kw. capacity, are separately driven by small Pelton wheels. Originally there were only two transmission lines—one to Chico (14 miles) and the other to Oroville and the Feather River gold-dredging district (32 miles). The Chico line has since been extended to Colusa, 40 miles further, and an additional line has been run to the junction of the Chico and Colusa lines. With the exception of the Oroville line, which is of aluminium (No. 2 B. & S. gauge), the conductors are of No. 6 B. & S. hard-drawn copper. Telephone lines, transposed every 10 poles, are run on cross-arms fixed on the main pole lines. Recently the Butte County Power Company was taken over by the Valley Counties Power Company, and considerable extensions were made, a 900-kw. Stanley generator, driven by a Doble wheel, being added, together with an additional bank of three 60-kw. step-up transformers for raising the generated pressure to 42,000, 52,500, or 63,000 volts, for the purpose of operating in parallel with the other power-houses of the system. The paper is illustrated by photo-blocks, including a ground plan and elevation of the 900-kw. set. B. P. S.

796. *The Dalles Power Transmission.* (Journal of Electricity, S. F. 18. pp. 157–163, March, 1908.)—*System:* Energy is transmitted 27 miles at 20,000 volts, three-phase, from White River Falls, Oregon, to The Dalles for lighting and power. The available fall is 131 ft., which is reduced to 119 ft. at the end of the head race, 1,200 ft. long. The generating plant consists of two three-phase 500-kw. 2,300-volt General Electric alternators, working at 60 ∿, and driven direct by Knight water-wheels. A 30-kw. exciter is driven by a separate wheel. The current passes through three 400-kw. air-blast transformers, which raise the pressure to 22,000 volts. The transmission line is carried by glass insulators on cedar poles, and consists of three No. 6 B. & S. gauge copper wires. At The Dalles, a substation equipped with three 375-kw. air-blast transformers provides for reducing the pressure to 1,100 volts for distribution. A large flour mill using one 200-h.p. and one 50-h.p. motor is connected. Glow lamps at 104 volts and enclosed arc lamps fed in series by a 35-light constant-current transformer are used in the town. A full description of the Knight water-wheel and the system of governing is given, with illustrations. A. H. A.

797. *Auckland Electric Tramways.* (Tram. Rly. World, 13. pp. 221–235, March, 1908.)—The tramways consist of 29 miles of single track (17 miles of route), and connect Auckland with Onehunga, serving a population of 70,000. The gauge is standard, and the rails weigh 92 lbs. per yard. Where the track is single it is laid at one side, so that a second track can easily be added. The rails are bedded on concrete longitudinal sleepers 18 in. wide by 9 in. deep, and are bordered with stone setts, with macadam between. The tongues of the points are 7 ft. 5 in. long, and are curved to 100-ft. radius. Special means are provided for draining both the rail grooves and the track between the rails. The overhead wire, No. 00 B. & S. gauge, is carried by iron and wooden poles, mainly centre poles, with examples of side poles and brackets, and span wires. The feeders are underground in the towns, and overhead, of bare copper, in the country; the former are insulated with vulcanised bitumen and drawn into earthenware ducts. The power-station contains four Babcock boilers with chain grate stokers, with economiser, and three engines built by Cole, Marchent, and Morley, Ltd., each giving

Digitized by Google

475 h.p. normal and 700 h.p. maximum, at 100 r.p.m., with steam at 150 lbs. pressure. The latter drive direct three 300-kw. generators made by the General Electric Co. (U.S.A.). There is also a 25-kw. set and four motor-driven boosters. The chimney shaft is of steel, 7 ft. in diameter inside, and 125 ft. high. Feed-water is obtained from the town mains, and condensing water from the harbour by means of electrically driven centrifugal pumps. There are two surface condensers, with Edwards' air pumps driven by motors. The rolling stock consists of nineteen single-deck and six double-deck bogie cars, and eighteen single-deck four-wheel cars made by the Brush Co. The cars are wider than usual, and have cross-seats; the six large cars are equipped with four motors each, the rest with two. Three kinds of brake are fitted on each car, some of the grades amounting to 1 in 8·8. All the motors are of 40 b.h.p., and give a maximum speed of 18 m.p.h. There are two car depôts, with workshops and stores. The article is very fully illustrated with photographs and drawings. A. H. A.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

798. *Rail Sections for Street Railways.* **B. J. Arnold.** (Eng. News, 49. pp. 190–191, Feb. 26, 1903. Extracts from the report to the Committee on Local Transportation of the Chicago City Council, Nov. 19, 1902.)—Dimensioned sectional drawings are given of the rails adopted by the Rapid Transit Co. of Philadelphia, of those used in Brooklyn, Boston, and New York, and of one proposed by the author for well-paved streets in Chicago. The most approved practice in American track construction is to lay the rails on longitudinal beams of Portland cement concrete, these beams being part of the concrete foundation supporting the pavement. The cost of a mile of single track is given as $23,965, exclusive of paving. The cost of paving per mile, including a 6-in. concrete bed, is: asphalt, $12,880; dressed granite, $18,400; vitrified brick, $12,650. F. B.

799. *Accumulator Traction.* **D. Civita.** (Elettricista, Rome, 12. pp. 57–64, March, 1903.)—The author disputes the opinion put forward by G. Semenza that, in spite of good results on the Bologna-S. Felice line, accumulator traction is not suitable for high speeds and heavy traffic. The author admits that for crowded traffic near large cities a third-rail or overhead conductor system is to be preferred. But on 80 per cent. of the railway lines of Italy, less than seven trains are run daily, and he considers that accumulator locomotives may be usefully employed in such cases, so as to substitute water power for steam. On the Bologna-S. Felice and Bologna-Modena lines such locomotives are used. The consumption of energy at the charging station is said to amount to 28 watt-hours per ton-kilometer, the maximum and average speeds being 52 and 45 km.p.h. respectively. A. E. L.

800. *Arendt Electrical Carrier-Tricycle.* **E. Dieudonné.** (Locomotion Automobile, 9. pp. 714–715, Nov. 6, 1902.)—This is a description, with plan and elevation, of an electrically propelled tricycle for the carriage of parcels. The carrier body can be exchanged for one fitted with two seats. The rear wheel is driven by means of a chain; the accumulators (twenty-four

[1] Non-electrical Automobiles are described in the Section dealing with Steam and Gas Engines.

Digitized by Google

cells), contained in two wooden boxes, being placed over the front wheels. The motor weighs about 50 kg., and is located nearly centrally. Each cell weighs 7·5 kg., and is 320 mm. high, 145 mm. long, and 88 mm. wide. The energy consumption, for a useful load of 150 kg., is about 0·7 h.p. on the level. The vehicle itself weighs 375 kg., and is capable of taking a load of 200 kg. The controller, which is placed towards the rear, behind the driver's feet, is worked by a lever with the left hand, and is arranged to give four speeds forward and two backward. For starting, the two halves of the battery are put in parallel, and later, when running, in series. Besides the electric brake a pedal-actuated brake is fitted. The motor runs normally at 1,500 r.p.m., and drives the rear wheel by means of a chain gear, giving altogether a reduction of 10 : 1. The rear wheel at 150 r.p.m. gives a speed of 18 km. per hour. The distance run with one charge is 60–75 kilometres. L. H. W.

801. *Third-Rail Contact.* **G. T. Hanchett.** (Tram. Rly. World, 18. pp. 235–237, March, 1903.)—The author discusses the efficiency of contact with the third rail, and describes the use of scrapers, notched wheels under heavy pressure, and brushes for removing snow and sleet from the rail. Contact shoes, as ordinarily made, are much too light and ought to be laminated. It is a good plan in snowy weather to warm the rail by passing a heavy current through it, either from the generating station or by means of a transformer car run along the track. [See also Abstract No. 512 (1903).] A. H. A.

802. *Safety Devices for Tramway Trolley Wires.* **D. S. Munro.** (Elect. Rev. 52. pp. 428–429, March 13 ; 472–473, March 20 ; and pp. 552–553, March 27, 1903.)—The overhead trolley system is declared to be pregnant with destructive and death-dealing possibilities, and many inventors are trying to find a remedy, amongst them the writer of the article. He describes various automatic switches he has devised, and at the same time points out the shortcomings of other methods, such as those by Salazer, Quin, the G.E. Co., and Krizik and Huinen. The descriptive matter and diagrams are something after the style of a series of patent specifications, and the reader is repeatedly reminded that the mechanical details and proportions would in practice differ from those drawn. As an exposition of how complicated and unsatisfactory all these trolley-wire automatic devices are, the article may be useful. The impartial reader will probably be forced to the conclusion come to by the Commission of Electrical Experts appointed by Santiago de Chili, that the only really safe remedy is to bury all telegraph and telephone cables.

E. K. S.

803. *Automatic Electric Control of Trains.* **G. E. Walsh.** (Elect. Rev. N.Y. 42. p. 203, Feb. 7, 1903.)—The author proposes a control from headquarters in the following manner : The line is equipped with an electric control system which enables the operator or train despatcher at headquarters to apply the brake on any engine running on the line. It is proposed to have in the main office of the railroad a perfect model of the tracks of the whole system, over which small miniature trains are running simultaneously with those on the regular tracks. These models are in electrical touch with the moving trains. When the latter stops the model engines do the same. As the model track is exactly the same as the large one, but on a very small scale, it is possible for the train despatcher to see when two trains are approaching on the same track. Small duplicates of the block signals are operated on the model, and when an engineer runs past a danger signal set against him the operator at

Digitized by Google

headquarters knows it. The whole control of the trains is made simple by this electrical connection. The operator can, by disconnecting the switch attached to his small model engine, apply an electrical brake to the engine corresponding to the model. In other words, the control of any engine can be taken immediately from the hands of the engineer. Moreover, the electric brake applied in this way at headquarters cannot be released by the engineer. Another system is suggested which is analogous to that described in Abstract No. 404 (1908), in which the throttle and air-brake are acted upon by electro-magnets through currents on the track. It can be operated so as to display white, red, or green lights in the cab, to show the engineer that all is safe ahead. Almost simultaneously with its display of a danger light it closes the throttle and applies the air-brake, so that the train comes to an almost instant halt. E. O. W.

ELECTRIC LAMPS AND LIGHTING.

804. *Flame Arc Lamps.* **J. Zeidler.** (Elektrotechn. Zeitschr. 24. pp. 167–172, Feb. 26, 1903. Paper read before the Elektrotechnische Verein, Dec. 28, 1902.)—The author describes the lamps constructed by the Allgemeine Elektrizitäts Gesellschaft, using carbons containing calcium compounds in the core. The lamps are divided into two classes, viz., flame arc lamps, in which the carbons are placed one above the other, and so-called intensive flame arc lamps, in which the carbons are placed side by side, meeting at an acute angle. The construction of the various forms is fully described. With flame arcs for direct current, a fire-clay "economiser" is used and placed immediately above the arc. This allows the use of thinner carbons, which are necessary for the production of a steady arc, seeing that an atmosphere more or less free from oxygen is collected about the tip of the upper carbon. In the intensive flame arc lamps, the two carbons pass through a horizontal framework, and are gradually lowered by the regulating mechanism. In this case, the tops of the carbons are left without cores for about 50 or 60 mm. of their length, and this causes an automatic extinction of the arc when the carbons have burnt away to this point. The carbons can be placed at various angles. Taking an alternate current lamp of 10 amperes, the arc remains below the carbons up to an angle of about 45°, and no electromagnet is needed to deflect the arc. Moreover, the use of a magnetic deflector does not increase the efficiency of the lamp, as is shown by figures here quoted, which were obtained by Siemens and Halske when testing a lamp with carbons inclined at an angle of 80°. The highest efficiency in this case was obtained without deflector, and it decreased the more the deflector was energised. The cause of this is to be found in the fact that the greater area of the arc produces a corresponding cooling of the gases, and the temperature is therefore lowered. The carbons used in these lamps are thinner than ordinary carbons, with a view to producing a steady light; moreover, the length of the arc is greater; consequently they burn away more rapidly. With an ordinary 8-ampere direct-current lamp taking 40 volts and using carbons of 16 and 10 mm. diameter, the carbons burn at the rate of 16 or 17 mm. an hour; with a similar lamp using "effect" carbons, *i.e.*, calcium-carbons, of 10 mm. diameter, the consumption is at the rate of 27·5 mm. an hour. With intensive flame arcs the carbons must be thinner still; taking an 8-ampere lamp for direct-current and 45 volts, with "effect" carbons of 8 and 7 mm. diameter, the consumption is at the rate of 42·5 mm. an hour, and with

Digitized by Google

carbons of 9 and 8 mm. diameter at the rate of 34 mm. an hour. In the latter case it is advisable to use an ordinary carbon for the negative pole, or at any rate one with small amount of calcium; otherwise the temperature is not high enough to produce instant volatilisation, and the negative tip is liable to be coated with molten drops, which cause unsteadiness in the light. The drop in the carbons of an 8-ampere direct-current intensive flame arc lamp, with carbons 325 mm. long and 8 and 7 mm. diameter, is between 5 and 6 volts. The carbons therefore cannot be much increased in length, partly because of the fall in volts, and partly because it is not easy to make straight and uniformly cored carbons of greater length. A form of lamp with double carbons has been made. Four flame arc lamps can be burnt on 220 volts direct current, and six on alternate current at the same pressure; four "intensive" flame arcs can be burnt in series on either direct or alternate current at 220 volts. A table is given showing the efficiency of a series of such lamps with a similar series of ordinary carbon lamps, from which it appears that an economy of from 50 to 70 per cent. is to be obtained by the use of intensive flame lamps. A large amount of NO_2 is generated during the combustion of the new carbons. Siemens and Halske have adopted a device for protecting the lamp from the action of this gas by filling the ash-tray from time to time with ammonium carbonate, which becomes gradually changed into ammonium nitrate. W. H. S.

REFERENCES.

805. *Wiring Rules of the Institution of Electrical Engineers.* (Inst. Elect. Engin., Journ. 32. pp. 498–514, March, 1903.) G. W. DE T.

806. *Elberfeld Suspension Railway.* (Engineer, 94. pp. 385–386, Oct. 24; 413–415, Oct. 31; 434–436 and 441, Nov. 7; and pp. 488–491, Nov. 21, 1902.)—The articles, which describe the construction and working of this railway, are very fully illustrated with detail drawings and photographs. [See also Abstract No. 1593 (1900).] G. W. DE T.

807. *Truck for Electric Service.* (Railroad Gazette, 34. p. 872, Nov. 14, 1902.)—This is a description of some powerful four-wheel passenger trucks for third-rail electric service. They are of interest on account of their unusual size and strength, and are comparable only to a heavy locomotive frame. The necessity for great strength is apparent when it is understood that each truck must withstand half the weight of a 100,000-lb. car and the torque of two 160-h.p. motors. C. E. A.

808. *Perfect Track.* (Street Rly. Rev. 12. pp. 842–843; Discussion, pp. 843–845, Nov., 1902. Paper read before the Meeting of the New York Railroad Club held in New York City, Sept. 18, 1902.)—A consideration of the best means for maintaining correct alignment, surface, &c., of a tramway. There are numerous interesting points raised in regard to maintenance of joints, design of fish-plates, flexible *v.* rigid roadbeds, &c. C. E. A.

809. *Electric Tramway Poles.* **G. G. Braid.** (Elect. Engin. Supplement, 31. pp. 1–5, Feb. 27, 1903.)—The author deals with the question of the strength and stiffness of side poles used for supporting the trolley wire. He considers the case of tapered and parallel poles, and of poles built up in sections; the calculations are fully worked out, both from the theoretical point of view and for a variety of special cases. W. H. S.

Digitized by Google

TELEGRAPHY AND TELEPHONY.

810. *The Cable Ships "Restorer" and "Patrol."* (Electrician, 50. pp. 757–761, Feb. 27, and pp. 800–808, March 6, 1903.)—The former is built by Armstrong, Whitworth and Co., with main engines by the Wallsend Slipway and Engineering Company. The latter is constructed and engined by Wigham, Richardson and Co. The cable gear in both is by Johnson and Phillips. The ships are for the Eastern Extension A. and C. Tel. Co. For the cabling, there is provided forward a double-combined picking-up and paying-out machine of Johnson and Phillips' latest pattern. This double machine is placed between the main and the spar deck, hatches being provided in the spar deck to expose the cable-gear drums when working. The two parts of this double machine are capable of being worked quite independently of each other, there being two separate engines, but the machine is so arranged that, should it be necessary at any time (such as in case of a breakdown to one engine), the engine for the port side drum may drive the starboard side drum, or *vice versâ*, while both engines may work on to either drum when the maximum lift is required. Johnson and Phillips have adopted a special disposition of the engines in these machines, placing them one forward of the machine and one aft of the machine, instead of having them side by side at one end of the machine as is usual, and by so doing have been able to reduce considerably the width of the machine, and generally to make it much more compact. The engines are twin high-pressure, with 8 in. cylinders and 8 in. stroke, for a working pressure of 170 lb. per sq. in., and each is capable of developing 110 b.h.p. when running at a speed of 800 r.p.m., giving a total of 220 b.h.p. for the machine. With this power the machine is easily capable of lifting a weight of 25 tons at the rate of 1 knot per hour, while the other speeds provided admit of lifts as follows : 10 tons at 2½ knots and 6¼ tons at 4 knots per hour. The drums, which are 5 ft. 8½ in. diameter by 1 ft. 9 in. wide between the flanges, are made to run loose on the shaft, in accordance with the makers' invariable practice, and by having the brake ring attached to the drum it is only necessary, when paying out, to have the drum and the "holding-back" gear running. The main brakes consist of steel straps with elm blocks encircling the brake ring, on which they are made to close by means of a double-thread screw actuated by handwheel through the medium of a worm gear, giving a very fine regulation for the lighter strains, and at the same time providing enormous holding power when necessary. At the steam trial of the cable machine, after it was fixed on board, we are informed that, after the engines had lifted the weight of 25 tons, one of these screw brakes held it "dead," and then by gently releasing the brake the weight was lowered very gradually, and under perfect control. Each brake strap is fitted with a water-service pipe with nozzles at intervals. The "hauling-off" and "holding-back" gear stands on the spar deck, and is driven from the geared drum by means of a chain drive, through a friction strap and "free-wheel" arrangement, in such a manner that it is driven in one direction only, viz., for picking up, whereas it runs free for paying out ; and, therefore, when it is necessary on a picking-up job to reverse and pay out a little slack, the gear is automatic in this respect. This is a great advantage over the old system, with which it was necessary to put a clutch in and out of gear. A screw gear

Digitized by Google

is also provided for traversing the haul-off sheave across the face of the drum to suit an "inside" or "outside" lead, and this can be worked while the machine is running. Screw brakes are provided on this "holding-back" gear. The special machine placed aft for paying out the longer lengths of cable over the stern is quite a departure from the old practice, the distinctive feature being the hydraulic brake. The cable drum is internally geared and is made to drive four cranks, which in turn give reciprocating motion to four plunger rods working in open-ended cylinders. Each rod carries two plungers, which are arranged to work one above and one below a transverse diaphragm in these cylinders. The diaphragm has ports, and is in two parts, the space between them being occupied by an adjustable grid having a similar set of ports. This grid has a few teeth on one part of its periphery into which gears a worm shaft. The cylinders being filled with water, the reciprocating action of the plungers forces the grid from one side of the diaphragm to the other alternately, the braking effect being regulated by the amount of the opening of the ports. No attempt is made to have the plungers or glands absolutely watertight, as this is quite unnecessary, the replace water which makes up the leakage serving as a cooling medium. This replace water is supplied from one of the ship's pumps, each cylinder having two inlets, one above and one below the transverse diaphragm, each provided with back-pressure valves. When the plungers are on the downward stroke there is no pressure below the diaphragm, and water is therefore free to enter from the service, while on the upward stroke water can enter above the diaphragm, thus keeping the chambers always full. One lever opens the water-service cocks, and one handwheel regulates all the moving grids in the diaphragm. The cylinders are enlarged at the diaphragm so that the port area is nearly equal to the full bore of the cylinders, thus allowing the plungers to run without offering any resistance when first starting up. In addition to the hydraulic brake, the machine is provided with a screw brake complete with water-service pipes, similar to those on the double machine forward. This would be used for holding a cable "dead," and it can also be used in conjunction with the hydraulic brake if required. The paying-out machine is provided with a double sheave "holding-back" gear, having screw brakes. There is no engine to the machine, but, in case it might be necessary to haul back at any time, a worm gear is provided, arranged to drive from the winch by ropes. The machine is very compact and occupies less space than one of the older type. There are three dynamometers, two forward and one aft, for registering the strains on the cables, and each of these are provided with Johnson and Phillips' improved arrangement of internal spring, which, coming into compression as the moving part of the dynamometer comes down, gradually reduces the effective weight, thus allowing very low as well as very high strains to be registered without need of adding or removing weights. At the stern of the vessel is the steam-driven "Lucas" sounding machine. This machine is suitable for sounding in depths up to 5,000 fathoms. As the steel wire is paid out it passes over a measuring wheel, the revolutions of which record on a dial the number of fathoms. A spring brake, which is capable of stopping the wheel instantly, is kept out of action by the tension of the wire during the run out. When the sinker strikes the bottom, the loss of tension allows the brake to spring back and stop the reel, and the depth is then read off on the dial. A small three-cylinder steam engine is fitted to the machine for winding in the wire. This wireless telegraph apparatus is the first practical application of the newest Lodge-Muirhead system. A few wires forming a strip about 2 ft. wide are elevated 17 ft.

Digitized by Google

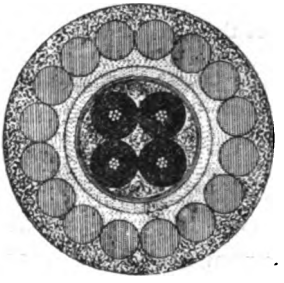
above the mast-head (*i.e.*, 102 ft. above the deck) and terminate at their lower end in a flexible cord and plug which can be connected either to the transmitting or receiving apparatus. The latter employs an ingenious coherer, consisting of a small metal disc which is continuously rotating in a tiny mercury bath, the surface of which is covered with oil. When under the influence of Hertzian waves the wheel and mercury are in electrical contact, but normally the oil ensures a high resistance between the two. No "tapper-back" is required therefore. The coherer is in connection with a syphon recorder. E. O. W.

811. *Wireless Telegraphy over Sea and Earth.* **H. B. Jackson.** (Roy. Soc., Proc. 70. pp. 254–272, July 8, 1902.)—The author describes a number of observations made on the transmission of wireless telegraph signals over the sea, and over land of varying character. These results give conclusive evidence that the etheric waves will pass through, over, or round land, but that a large proportion of their energy is lost in doing so. Also that the screening effect of the land varies with its nature, and is greater for iron ores than for limestone, and greater for the latter than for soft rocks. The effect varies also with the height, thickness, and contour of the land, but, in all cases, the intervention of land decreases the practical signalling distance between two stations as compared with the distance, obtainable over the open sea. The presence of material particles, such as dust and salt held in suspension in a moist atmosphere, also reduces the signalling distance, probably, as the author suggests, by dissipating and absorbing the waves. Electrical disturbances in the atmosphere exercise a most adverse effect on the transmission, in addition to affecting the instruments by lightning discharges. They are most prevalent in tropical and subtropical regions, but are specially noticeable in the Mediterranean. A very curious effect observed was that, very frequently, signals were unreadable at certain distances, but became distinct again when the distance between the ships was either increased or diminished. It occurred only with a transmitter in which there was rapid damping, and could always be remedied by replacing such a transmitter with a syntonic one, even if of less power. The author attributes the result to the irregularity of the train of waves giving rise to different types of disturbance at different parts of their path, which may not have, at certain points, the necessary cumulative effect on the receiving circuit. Some difficulty was experienced in obtaining exact numerical results, owing to the uncertainty of the coherer, as the filings coherer cannot be depended on to give absolutely similar consecutive indications under similar conditions of excitation. In long-distance work, it was found that only about 95 per cent. of the signals were correctly received. G. W. DE T.

812. *Effect of Daylight on Wireless Telegraphy.* **G. Marconi.** (Roy. Soc., Proc. 70. pp. 344–347, July 29, 1902.)—The author's experiments on a passage from Southampton to New York did not show any effect of daylight up to distances of 500 miles. At distances exceeding 700 miles, however, the day signals failed entirely, while the night signals were clearly decipherable up to a distance of 2,099 miles from the Poldhu transmitting station. Subsequent further experiments showed that between North Haven and Poldhu, a distance of 152 miles, the height of the four vertical receiving wires at the former station had to be increased from 12·1 m. for night work to 18·5 m. for day work. G. W. DE T.

Digitized by Google

813. *Anglo-Belgian Telephone Cable.* **Leduc.** (Soc. Belge Élect., Bull. 20. pp. 1–25, Jan., 1903.)—The cable made by Henley's at North Woolwich and laid last year is as follows :—



Each conductor is of 7-strand copper weighing 160 lbs. per naut., and is enclosed in a dielectric of three coatings of guttapercha with Chatterton in thin coatings between ; the weight is 800 lbs. per naut. The insulation was tested, after fifteen days' immersion of the core, with 5,000 volts at 100 periods for ½ hour. Subsequently an ordinary insulation test at 300 volts was taken, and a minimum resistance of 500 megohms per mile exacted. The maximum capacity was 0·275 m.f. per mile. The four conductors are helically wound round a core of hemp cord steeped in tar, and interstices secured with the same ; the whole core is served with ozokerite tape, and then with brass tape to provide against teredos. Upon this is a second cotton tape, and then a covering of best Russian tanned hemp. The armour as shown above is of galvanised iron wires, which, when thoroughly dried and warm, have been immersed in tar exempt from naphtha. Over the armour are two coverings of three-ply hemp wound in opposite directions. The complete cable was then run through compound of pitch, bitumen, and resin oil. In laying, the difficult end was that on the Belgian coast, owing to the shallows ; this was accomplished by the British Post Office steamer *Alert*, of light draught, and in deeper water the work was done by the *Monarch*. Length of the cable is 47·3 nauts.—a little more than double that of the cable from Dover to Calais. The total length of the circuit London to Brussels is 394·3 km. Overhead wires, copper or bronze, each 800 lbs. per mile, are run on posts with telegraph wires. E. O. W.

REFERENCE.

814. *Düsseldorf Telephones.* **Kehr.** (Elektrotechn. Zeitschr. 24. pp. 29–31, Jan. 8, 1903.)—This is an account, with diagrams and illustrations, of the new installation at the Düsseldorf exchange. R. A.

Digitized by Google

SCIENCE ABSTRACTS.

Section B.—ENGINEERING.

NOVEMBER 1903.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

815. *Steam Turbines and Heat-engines.* **A. Stodola.** (Zeitschr. Vereines Deutsch. Ing. 47. pp. 1–10, Jan. 3; 47–54, Jan. 10; 127–131, Jan. 24; 164–171, Jan. 31; 202–206, Feb. 7; 268–275, Feb. 21; 334–341, March 7; and p. 620, April 25, 1903. Report read before the Hauptversammlung des Vereines Deutscher Ingenieure at Düsseldorf, 1902.)—The general theory of steam-turbines is treated with great completeness from both the mechanical and the thermodynamical point of view, and also from both the mathematical and experimental side. Particular turbines—de Laval's, Stumpf's, Zoelly's, Parsons', Rateau's—are then treated in detail, and a short review of heat-engines at large concludes the report. R. E. B.

816. *Friction in the Bearings of High-speed Machines.* **O. Lasche.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1881–1890, Dec. 13; 1932–1938, Dec. 20; and pp. 1961–1971, Dec. 27, 1902.)—Experiments were undertaken by the Allgemeine Elektrizitäts Gesellschaft in view of the high-speed traction work which they had in hand, and of turbine-driven machines which they were constructing. The author gives a short summary of work done by Thurston, Tower, and Woodbury between 1873 and 1884, but none of these observers carried their experiments beyond a rubbing speed at the journal surface of 6 m. a second, or a temperature in the bearings of more than 90° C. Most of the work was done at much lower limits. In the following summary of the author's paper, p is the specific pressure on the bearing in kg. per sq. cm., v the velocity of rubbing at the journal surface in metres per second, t the temperature in the bearing in degrees Centigrade, and μ is the coefficient of friction. The apparatus used is first described, together with the methods of observation and measurement. The effect of p on μ is first determined, t varying between 50 and 100, and p between 1 and 15. The coefficient of friction decreases with increasing pressures in the bearings. Taking $t = 50$, and $v = 10$, the results roughly approximate to the fact that $p\mu = 0{\cdot}04$, for journals of steel, nickel steel, or wrought iron running

Digitized by Google

in bearings of bronze, white metal, or mercury alloy. Any increase of bearing surface, by decreasing p tends to increase μ, supposing, of course, that the speed of rubbing remains as before. It follows from this, that with a given load and a given velocity of rubbing, it is a disadvantage, from the point of view of friction, to have long bearings and journals of large diameter. With p constant, Thurston found $\sqrt[5]{v}$ proportional to μ up to $v = 6$. Bach found, from an examination of Tower's experiments, that μ was proportional to $\sqrt{v}$ up to $v = 2{\cdot}4$, this being really in agreement with Thurston, as shown by Stribeck. The author's experiments show that for values of v greater than 10, μ is nearly constant, and with $p = 6{\cdot}5$, and $t = 50$, μ is 0·00615, with bearings and journals as before. With increasing temperatures, μ decreases, and between temperatures of 40° and 100° C., the product μt is practically constant. With $p = 6{\cdot}5$, we have $\mu t = 0{\cdot}3$; therefore the equation $p/\mu = 2$ is true for all values of p between 1 and 15, of t between 30 and 100, and of v between 1 and 20. Journals were constructed of various materials, viz., nickel steel, Siemens-Martin steel, and wrought iron; but results were not much affected by these variations. With $p = 6{\cdot}5$, $\mu = 0{\cdot}008$ for steel and wrought iron, and 0·006 for nickel steel, with $v = 10$, and $t = 50$. The hardness of the surface has therefore little to do with it; wrought iron lay between nickel steel and Siemens-Martin steel in the results; and microscopical examination showed that the polish of the nickel steel was slightly rougher than that of the others. Bearings were made lined with bronze, white metal, and mercury alloy; but here again the difference in the readings was not very marked. The choice of metals for bearings depends largely on other considerations, and in the case of machines with heavy flywheels or of those which should not be stopped suddenly, white metal is to be preferred. Different lubricants were employed, viz., imperial oil, rape oil, and sperm oil. There was little difference observed between these oils, when once full speed was reached; but on starting the machine, the friction was very different, sperm oil being the best, and imperial oil the worst. The physical properties of the oils themselves at high temperatures are, however, more important. Whether the lubricant is conveyed by pressure to the bearings, or by rings or other means, must depend on the circumstances of the case under consideration. The important thing is to know under what conditions the oil actually reaches the bearing surfaces, and the amount of oil which is distributed by the ring, or other systems, under known conditions of running. Experiments were carried out to find how much oil was conveyed under given circumstances by the ordinary ring system of lubrication, the oil being collected and drained away as it passed through the bearings. It was found that the amount increased with the speed up to about 2,500 r.p.m. The amounts also varied very considerably with the direction of rotation, and the quantities which flowed out of a bearing at the two ends were very different. The play allowed in the bearings has great influence on the friction. With a shaft 260 mm. in diameter, and $v = 10$, $t = 50$, the friction decreases rapidly up to about 1·5 mm. clearance, with $p = 1$; with values of p between 10 and 15, the friction decreases steadily but more slowly up to 2·5 mm. clearance. With a given clearance, the friction increases at first with p, but becomes nearly constant after p reaches the value 7. Mention is made of a specially constructed bearing which consists of three bearings, one within the other, the whole being supplied with oil under pressure. It was made for a 400-kw. turbine, running at 3,000 r.p.m., and has a total play of 0·35 mm., with a shaft 110 mm. in diameter, the temperature of the bearing being 45° C. above that of the atmosphere when fed with 7·5 litres of oil per minute under a

Digitized by Google

pressure of 5 atmospheres. A series of experiments was also undertaken to determine the dissipation by radiation and the temperature rise in the bearings with different forms of construction and with different dimensions of bearings. These were carried out, partly by filling the bearings with oil and passing current through a spiral immersed in the oil, and taking readings when a state of equilibrium was reached; and partly by observations on running machines, oil being supplied at different temperatures and pressures. For particulars and results of these experiments, the original articles should be consulted. Observations were made in which the temperature of the bearings rose to 132° C.; at about 125° the oil appeared to lose some of its lubricating properties, and the friction increased accordingly. Some bearings were also constructed in which 32 holes were bored to receive thermometers, and readings were taken which are graphically reproduced. The articles contain a large number of curves, many of which are arranged on the trilinear coordinate system, showing the relations between three variables. W. H. S.

817. *Operation of Steam Turbines with Highly Superheated Steam.* **E. Lewicki.** (Zeitschr. Vereines Deutsch. Ing. 47. pp. 441–447, March 28, 491–497, April 4, and pp. 525–530, April 11, 1903.)—The writer describes some very elaborate investigations which he made upon a de Laval turbine, and sets forth the conclusions at which he has arrived. The machine employed in the experiments has a speed at the turbine shaft of 20,000 r.p.m., this being reduced by gearing to 2,000 r.p.m. It has a normal capacity of 30 b.h.p. when operated at a pressure of 7 kg. per sq. cm., and non-condensing. The peripheral speed of the 200-mm. diameter turbine wheel is 209 m. per sec. The writer comments on the custom of expressing the steam consumption in kilograms per horse-power-hour at a given degree of superheat, without consideration of the extra expenditure of energy required to bring the steam to this degree of superheat, and recommends instead that the consumption should be expressed in heat units. The de Laval turbine is the only one at present capable of withstanding the highest degree of superheat. The experiments were carried up to 500° C., and no insuperable difficulty was encountered. The bearings are inaccessible to the hot steam and run cool, nor can the lubricating oil gain access to the steam, which may be again directly employed for boiler feed. For the bronze nozzles and valves, others of iron had, however, to be substituted on account of the smaller coefficient of expansion of iron. Wear of the turbine blades is found to be altogether absent with highly superheated steam. The strength of steel is known to be unaffected up to 300° C., and the turbine wheel, with the highest degree of superheat, will always cool the steam down to this value. By employing a regenerator, the use of a very high degree of superheat permits of high economy with low steam pressure. Tests with steam at 500° C. and a pressure of 7 kg. per sq. cm. showed an increased economy (in thermal units) of 16 per cent. In these tests the exhaust steam still had a temperature of 343° C. Enough of the corresponding heat energy may still be recovered to bring the increase of economy for 16 per cent. up to 30 per cent. This regenerative process, by which a large part of the energy in the exhaust steam is employed in raising fresh steam, is described in the article, though it has not yet been fully carried out in practice. The method permits of obtaining the advantages incident to the use of low steam pressure for de Laval turbines. Running condensing, the percentage economy in heat units is less; nevertheless, with single-stage turbines, the increased economy

Digitized by Google

is enough to constitute a decided advantage. The tests showed that the friction of the turbine wheel decreases very rapidly indeed with increase in superheat; hence the mechanical efficiency increases.

The writer considers that, with a pressure of only 1·5 kg. per sq. cm., a good vacuum, and superheat to 550° or 600° C., the steam turbine of this type, with regenerator, will, in fuel consumption, equal the best piston engine running condensing and with saturated steam. In the interests of minimum friction and minimum radiation from the turbine casing, the turbine wheel diameter should be small and its speed high, and gear reduction should be used. Worm gearing of 95 per cent. efficiency is already obtainable, and this loss is much less than is incurred in other ways in avoiding the use of gearing by means of multiple-stage slow-speed turbines. The writer is sceptical as to the success of the use of steam at 300° C. in the new Parsons-Brown-Boveri multiple-stage turbines at Frankfurt a.M. He proposed to make experiments on a double or compound turbine in which the first shall operate with steam at high pressure and moderate superheat (350° C.), after which the steam shall be raised to 500° C. or 600° C. and admitted to the low-pressure turbine. For this purpose he will use a high-pressure boiler, and two superheaters to give these respective temperatures. He also proposes a plan whereby a high-pressure, slow-speed piston engine exhausts into an intermediate receiver which serves as supply for a low-pressure condensing turbine. By such an arrangement it would be permissible in the receiver to bring the steam to a degree of superheat far higher than would be compatible with the properties of the piston engine. The slow-speed piston engine would drive a transmission directly, while the energy of the high-speed turbine would be employed in driving a dynamo. H. M. H.

818. *Superheating in Central Station Engines.* **A. Vanderstegen.** (Soc. Belge Élect., Bull. 20. pp. 98–118; Discussion, pp. 119–124, March, 1903.)—After a general review of the subject in its modern aspect, dating from the Mulhouse school of Hirn and his pupils, the author discusses some tests with an economical type of engine in order to obtain the laws applying to this type. The tests were carried out by Schröter, of Munich, and Vinçotte, of the Association for the Inspection of Boilers, their results being elaborated in a series of tables and diagrams which accompany the paper. The tests were carried out by each experimenter independently, with a compound engine, having high-pressure cylinder 325 mm. diameter, low-pressure cylinder 560 mm. diameter, stroke 850 mm., and 127 r.p.m. A direct-coupled dynamo was employed, the current from which was absorbed by liquid resistances, so that the output was maintained constant for each test; the boiler was a De Naeyer multitubular, and the Maiche superheater was independently fired so that the temperature of superheat could be controlled. Every precaution was taken to have correctly calibrated instruments and correct weights and temperatures. The total error was brought down to 2 per cent. Three series of tests were made by Schröter: the first, to determine the consumption of saturated steam for different powers; the second, with superheated steam of 300° C. superheat under the same conditions; and the third, to ascertain the consumption of steam superheated to different temperatures up to 350° C. for a normal load. Vinçotte's series was more varied, being made in duplicate, one with the high-pressure cylinder steam-jacketed and one without; and they measured the consumption of steam for different loads at temperatures ranging up to 350° C. above saturation. For normal load the temperatures were carried to 375° and

Digitized by Google

400°. The diagrams, given in three plates, embody Vinçotte's results and they exhibit the concordance of the different tests and the absence of sensible errors. Schröter obtained, with the small compound engine of 250 i.h.p., with saturated steam, a minimum consumption of 5·5 kg. per i.h.p.-hour, and with superheated steam a consumption as low as has been obtained with triple-expansion engines of 3,000 h.p. at equivalent temperatures. As deduced from the tables the relative economy in weight of *steam* due to superheating amounts to about 20 per cent. at 300° and 30 per cent. at 350°. But these are only apparent economies, because the consumption of *heat* must be considered, and superheated steam represents more heat than saturated steam. The real economy due to superheating, as well as the reduction of the consumption of steam, is proportional to the degree of superheat or the temperature of steam entering the cylinder above that of saturated steam. This is the author's statement of the law deduced from the diagrams, and it holds good up to 350°, but above that point the economy is diminished, and difficulties of lubrication, and from expansion of the metal, increase. The real economy will be about 9 or 10 per cent. with a temperature of 300° C., and about 14 or 15 per cent. with 350° C. superheat in the case of an engine economical with saturated steam—more in the case of defective types. The author investigated the most economical load corresponding to an extended rate of expansion, this rate being the same for all temperatures used. The most favourable expansion was found to be about 15 times the volume admitted at 9 atmospheres, and the range lying between 10 and 25 per cent. of the admission was found to be equally economical. This is important, in view of the varying demands of central stations, as showing that the consumption of steam may be economical within close limits as the load varies between half and full load. This gives the steam engine an advantage over turbines and gas engines. The following points are also dealt with, viz.: The influence of speed of rotation on steam consumption, accelerated speed having the advantage of reducing dimensions and radiation; the influence of steam jackets, these being found to be unnecessary for the h.p. cylinder with 250° of superheat, and for the l.p. cylinder with 350° superheat; the consumption of heat and the best temperature to employ; the regulation of temperature; the section and covering of steam pipes and the velocity of the steam in them; and the use of bronze and other substances affected by high temperature. In the *discussion*, **Léon Gerard** referred to the economy obtained at the Berlin station of Oberspree, which was less than that of the author. He also raised questions as to velocity of superheated steam and the fuel economy of superheater. In all installations it is necessary to observe closely the temperatures and prevent sudden variations. The **Author,** in reply, stated that according to **Datterer,** Director of the Berliner Electricitäts Werke, the economy due to superheating was about 8 to 9 per cent., the engines not being suitable for use with saturated steam, the sections of piping being too small and no jackets existing. About 25 per cent. of the velocity of saturated steam was the increase of velocity required. Replying to **Malengraux,** the normal pressure in the tests was 9 atmospheres, but some experiments were made also at 7 atmospheres, with similar results. Answering **W. Kummer,** the use of superheaters simply reduced the weights of coal and water used, but not the weights of engine for a given power. F. J. R.

819. *Efficiency of Non-Conducting Coverings.* **S. H. Davies.** (Soc. Chem. Ind., Journ. 22. pp. 198–200; Discussion, p. 200, Feb. 25, 1903.)—The author

Digitized by Google

gives the results of tests of various materials which may be used for covering the walls of cold chambers, lager-beer cellars, fermenting rooms, and the like, or for insulating brine pipes against heat transmission, the highest temperature employed being that of boiling water, and the tests being continued for from 20 to 60 minutes. Four tables give Experimental Results, Coefficients of Conductivity, Density of Materials, and Cost of Material per Unit Volume. Tables II. and III. are here given.

COEFFICIENT OF CONDUCTIVITY (PER 1° CENT.).

Air-dried Material.	Moisture. Per cent. Loss at 100° C.	(a) B.Th.U. per sq. ft. per hour.	(b) Calories per sq. m. per hour.
1. Slag wool (light)	0·2	0·054	0·045
2. Hair felt	7·3	0·058	0·048
3. Light magnesia	3·4	0·062	0·051
4. Granulated cork	4·0	0·069	0·057
5. Slag wool (heavy)	0·2	0·07	0·058
6. Kieselguhr	3·4	0·073	0·06
7. Flaky charcoal	4·7	0·082	0·068
8. Pumice	0·8	0·095	0·079
9. Sawdust (spruce)	9·0	0·096	0·08
10. Asbestos fibre	0·6	0·136	0·112
11. Sawdust (very moist) ... approx.	50·0	0·298	0·247
1. Air space with bright metallic surfaces and two layers of glazed paper intervening ...		0·077	0·064
2. Air space with bright metallic surfaces		0·093	0·077
3. Air space with dull-black surfaces		0·163	0·135

DENSITY OF MATERIAL.

Material.	(a) Weight in lbs. per cubic foot.	(b) Weight in kilos per cubic metre.
1. Granulated cork	6·1	98
2. Hair felt	7·9	127
3. Slag wool (light)	8·6	138
4. Light magnesia	10·1	167
5. Sawdust (spruce)	13·1	210
6. Flaky charcoal	14·5	233
7. Asbestos fibre	14·5	233
8. Kieselguhr	15·0	240
9. Pumice (small)	25·0	401
10. Slag wool (heavy)	32·9	527

The original paper should be consulted for description of the apparatus employed and for several practical considerations and deductions. *Discussion.*—**J. W. Cobb** pointed out that the temperature of superheated steam induced carbonisation and consequent ineffectiveness of some materials for covering steam pipes, and alluded to the effect of binding material and to the difference between air-spaces permitting and not permitting convection currents. The **Author**, in reply, promised another note on the use of

Digitized by Google

binding materials and the insulation of steam pipes. Convection currents must be prevented. The value of an insulator depends on the real conductivity of the solid and on the volume and distribution of the contained air. [See also Abstracts Nos. 947 (1902) and 889 (1903).] F. J. R.

820. *Boiler Economy.* **E. S. Farwell.** (Eng. Mag. 24. pp. 896–900, March, 1903.)—The author discusses the fundamental principles which should govern boiler design, and advocates some radical changes. He maintains that in an ideal boiler plant, the furnace should be one in which the minimum amount of air requisite for complete combustion thoroughly percolates the fuel, and combustion is completed before the gases are cooled below the temperature of ignition. The boiler, he considers, should be so designed as to present, at any point in the path of the gases, the maximum temperature difference between the gases and water, and to reject always and only the coolest gases. He advocates, wherever possible, the replacement of chimneys by power-fans, combined with utilisation of the heat contained in the escaping gases, which latter may be much reduced by the suggested changes in design. G. W. DE T.

821. *Marine Water-Tube Boilers.* **H. C. Dinger.** (Eng. News, 49. pp. 328–331, April 9, 1903. From the Journal of the American Society of Naval Engineers.)—This is a long and practical paper, giving a minute account of the performance, for over five years, of the water-tube boilers of the gunboat *Marietta*, of the U.S. Navy. The efficiency of the boilers was maintained, with few repairs, at about 80 per cent. of the contract trial power, when exposed to ordinary conditions of working on board ship. No difficulty was experienced in maintaining the feed-water level, or in keeping the tubes clean, even when some sea water was mixed with the feed. A list of the repairs carried out is given, and the parts of the boiler most subject to damage are pointed out, as well as defects in the arrangement, which sea-going experience has demonstrated; and the paper concludes with some practical observations and suggestions as to the design, construction, and testing—as well as the ordinary operation—of naval boilers of the straight water-tube type. The author is the chief or senior engineer officer of the vessel, and has closely studied the operation of the boilers under his charge. It is impossible to represent the paper adequately in a short abstract. [See also Abstract No. 702 (1900).] F. J. R.

822. *Naval Boiler Tests.* **J. Halligan.** (Eng. News, 49. pp. 332–335, April 9, 1903. From the Journal of the American Society of Naval Engineers.) —After some general observations regarding the two classes of water-tube boilers in naval use, viz., the bent-tube class in torpedo boats and the straight-tube class in larger war vessels, the author, who is an officer in the U.S. Navy, criticises the straight-tube boiler of to-day and indicates the requirements of the "boiler of to-morrow." The bulk of the paper is thereafter devoted to a description of the construction and testing of a Hohenstein marine boiler [see Abstract No. 450 (1903)]. The boiler, which has been under test by the Bureau of Steam Engineering since April, 1901, is of 750 estimated h.p., and was built to the requirements of the "Denver" class of cruisers. It has been tested, with both coal and oil fuel, under varying conditions of draught. The equivalent evaporation from and at 212° F. has ranged from 166 lbs. to 709 lbs. per sq. ft. of grate surface per hour, the draught having varied from natural draught up to 3¾ in. of water column, but only remained for short periods at

Digitized by Google

this latter pressure. The pressure of steam in all the tests was 275 lbs. The maximum evaporation was obtained by burning oil, the lower tubes having been frequently exposed to a temperature of 2,200° F. Tables of results of the tests and of comparison with other straight-tube boilers in the U.S. Navy accompany the paper. F. J. R.

823. *Peat Fuel.* **A. Dal.** (Eng. Mag. 24. pp. 204–215, Nov., 1902.)—The author describes several types of peat-milling machines, and gives some of the results obtained in various parts of Europe with peat-coke. He advances reasons for believing that peat may be employed with advantage for the generation of power-gas. Peat should give at least as good results in Mond gas generators as coal slack containing 60 per cent. of carbon, and the extra amount of water in the peat would obviate the cost of generating steam, as required in the Mond process with slack. Transport costs would be nearly double those for coal, and therefore the peat should be used for the generation of power in situ. G. W. DE T.

824. *Tests of Mechanical Stokers.* **G. A. Hutchinson.** (Eng. News, 49. pp. 272–273, March 26, 1903.)—This paper records some tests made with two Heine water-tube boilers fitted with mechanical stokers of the sloping-grate variety, the coal being moved downwards from a magazine by the movement of the grate bars, and compared with tests on a 300-h.p. water-tube boiler fitted with chain-grate stoker. The coal used was Schlecht lump and Besser slack, but the results were poor and did not compare favourably with hand-firing with the same coal. The tests are recorded to show that the peculiar features of the fuel should be studied before deciding to instal any special stoker or system of firing. F. J. R.

825. *Improvements in Engine Indicators.* **A. Wagener.** (Zeitschr. Vereines Deutsch. Ing. 47. pp. 848–852, March 7, 1903.)—Attention is drawn to the well-known sources of error due to the stretching of the indicator cord, especially in fast-running gas engines. It is pointed out that the uncertainties are most marked at the two ends of the stroke, and it is stated that this is particularly unfortunate in the case of engines of the Oechelhäuser or Körting type, for it is just at those points that information is most required. The first part of the paper is taken up with the description of a new form of "stroke-reducing" mechanism, but this is not intelligible without the illustration. No results obtained with this outfit are given. The second part of the paper contains a description of the construction of a type of indicator in which a ribbon of paper is driven at constant speed under the indicator pencil, and meanwhile a second scribing point gives a time-reference line. The latter is operated by means of a simple contact wheel driven by one of the engine shafts, and thus transmitting electric signals which are recorded by a simple form of magnetic scriber. The details of construction are fully and clearly illustrated. Various methods of proceeding from the time diagram, as recorded, to the piston-path diagram are discussed. It is stated that in taking a number of similar diagrams no appreciable error is committed by the use of a constant reduction factor for the area as measured on the time diagram. R. T.

826. *Testing Indicator Springs.* **E. Förster.** (Zeitschr. Vereines Deutsch. Ing. 47. pp. 319–321, Feb. 28, 1903. Paper read before the Breslau Local Section.)—The author describes some simple methods by which it is possible

Digitized by Google

to test indicator springs from time to time. Such testing is more particularly important in the case of springs which have been used for some length of time. The first method consists in connecting the indicator together with a manometer to the engine cylinder, and then putting the engine crank on the dead centre. Steam is then admitted to the indicator and manometer through the indicator cock, which can be used to throttle the steam to any desired amount. If the manometer has a scale reading over a long range, a series of readings can be obtained for the calibration of the spring. The second method consists in loading the indicator with known weights and noting the compression of the spring, the cylinder being previously warmed to the corresponding temperature. This last precaution is very necessary, seeing that friction is a very important element, and any method depending on a cold test with a correction for temperature is practically useless. Figures relating to a certain test are given, and show that the two methods give closely agreeing results. W. H. S.

GAS AND OIL ENGINES.

827. *Internal Combustion Engines.* **W. H. Booth.** (Eng. Mag. 24. pp. 216–222, Nov., 1902.)—After a brief account of early types, the author discusses the disadvantages of the presence of a considerable percentage of hydrogen in gases used for working these engines. One of the advantages of the Diesel engine is that the harmful results produced by hydrogen are obviated, with the exception of some loss in thermo-dynamic efficiency, due to the high latent heat of the steam formed by its combustion.

G. W. DE T.

828. *Butler Three-Cylinder Compound Gas-Engine.* (Mech. Eng. 11. pp. 140–143, Jan. 31, 1903.)—This engine, which is vertical and of a type suitable for large powers, indicates 100 h.p. and weighs 7 tons. Lift valves, cams, and levers are all dispensed with. There are three cylinders and three cranks; the two smaller high-pressure or explosion pistons move together. The low-pressure crank is set at an angle of advance of over 180° to the others, a balanced rotary valve, revolving at one-fourth the speed of the engine, being used to control the admission to and exhaust from the two explosion cylinders as well as the exhaust from the expansion cylinder. The action of the engine is as follows: Expansion takes place in the large cylinder for about three-quarters of the stroke. At this point a vacuum is created above the descending piston, with the result that the remnants of the burnt gases in that high-pressure cylinder which has just made its effective stroke are sucked out. On its return the low-pressure piston expels these burnt gases. The two high-pressure cylinders are fired alternately, and the large cylinder acts as low-pressure cylinder first for one and then for the other. The charge is mixed before admission to the cylinder. Only the two explosion cylinders and covers are jacketed. Drawings and indicator-diagrams are shown.

C. C.

829. *Comparison of Benzine and Alcohol as Fuel for Motors.* **W. A. T. Müller.** (Zeitschr. Vereines Deutsch. Ing. 47. pp. 59–62; Discussion, p. 62, Jan. 10, 1903. Paper read before the Fränkisch-Oberpfälzischer Bezirks-Verein, April 10, 1902.)—Investigation in Nüremberg by von Paller, assisted by the author. The relative consumption of benzine and alcohol at different

Digitized by Google

compressions in a 2-h.p. motor was investigated, but the calorific value of the fuels was not tested, and a commercial rather than a scientific result was aimed at. Compressions from 3 to 7½ atmospheres in excess were investigated, the motor being kept at constant load throughout, and the fuel consumption noted. The general result was that the motor took about twice as much alcohol as benzine—by weight—the alcohol being 90 per cent. (vol.? and the benzine having a density between 0·69 and 0·78 according to the sample used. There was a difficulty in starting the motor with pure alcohol, and a tabulated statement of results refers only to mixtures of alcohol with from 5 to 20 per cent. of benzine. Calculations of cost are made on the basis of benzine at 25 marks per 100 kilos, and alcohol 90 per cent. at 15 marks per 100 litres. The most favourable condition using alcohol appeared to be a high compression (7·5 atmospheres), and in this case the cost per h.p.-hour was 8·47 pf. for benzine of specific gravity 0·740 and 15·82 pf. for alcohol with 5 per cent. benzine. The waste gases from the alcohol were found to contain acetic acid, and the motor did not appear to be cleaner after running on alcohol than after running on benzine. R. T.

830. *Function of Auxiliary Spark-gaps in Electric Ignition.* **W. Pfitzner.** (Motorwagen, 6. pp. 55–61, Feb. 28, 1903.)—This is an article dealing with the auxiliary spark-gap, as applied to petrol motors, with a theoretical investigation into the causes of its beneficial action on the ignition, especially in cases where the sparking plug has a sooty or watery deposit on its surface. The author first describes a simple experiment where a drop of water is placed so as to join the platinum points of a plug connected to a coil, without a second spark-gap. On the current being switched on no spark will pass as a rule, but if it is left on for a little time, bubbles will be generated in the drop which will begin to boil and give off steam. If now the high-tension circuit is broken near the plug, a spark appears at this break, and at the same instant a spark passes between the points of the plug in spite of the presence of the water-drop. It is easily found that a necessary condition for the production of this spark is that the auxiliary gap shall have a certain minimum length. If it is smaller than this, no spark passes at the points of the plug; if too large, such sparking as does take place is diminished in intensity. On shorting the original gap, sparking ceases at both places. The paper then deals with a simple mathematical investigation, illustrated by curves of p.d. and current, into the action of the spark-coil, the gist of which is as follows: The proper adjustment of the condenser capacity in a coil can give rise to increased potential at the terminals of the secondary owing to resonance effects, but such potential can only be obtained if the secondary circuit has not been completed by sparking taking place at the first, lower values of maximum potential. Such sparking will always take place if the air-gap is smaller than the greatest sparking distance, and therefore, with such a gap, the higher maxima are never obtained; on the other hand, the gap must not be so large that with the given potential a spark will not pass at all. If a partially conducting shunt to the sparking points of the plug exists, as when the surface of the insulator is covered with soot or a watery deposit, though the resistance between the points may be high (10,000 or 15,000 ohms) from the ordinary point of view, for such potentials (20,000 volts about) the conductivity is considerable. When the primary circuit is completed, the secondary, being closed through this high resistance (across the soot), a current at once begins in the secondary as soon as even a very low potential is induced in it. This current will only grow slowly, owing to the low potential and high

Digitized by Google

resistance of the circuit, but eventually reaches a fairly high value. (The bubbling and steaming in the first experiment showed that a large amount of heat was generated), but the potential never rises to the value required to produce sparking, and so no spark appears at the plug, the potential having been wiped out in the early stages by the generation of the current. From this investigation the author now considers the action of the auxiliary gap to be easily explained. In the secondary circuit a gap is provided, somewhat longer than that between the points of the plug, and as near to it as possible. As the circuit is open (at the larger gap) the potential will rise rapidly till it reaches the value necessary to bridge the gap. In discharging across it the current rises slowly, owing to the discharge in the first instant going through the high-resistance leak across the plug, and consequently the potential is only lowered slightly. With the starting of this current, however, a change in the distribution of the potential in the circuit between the secondary terminals of the coil has arisen. The p.d., which was hitherto maintained between the coil ends, distributes itself according to Ohm's law, and, whereas the whole p.d. existed formerly between the points of the auxiliary spark-gap, now, owing to the spark at that gap being a good conductor, and its effect in lowering the p.d. therefore very small, almost all the potential drop is caused by the high-resistance leak across the plug, so that after an exceedingly short interval the whole remaining p.d. is transferred to the points of the sooty sparking plug. If this p.d is still large enough to break down the air-gap at the plug, a spark passes in spite of the leakage, when, this air-gap being also made conducting by the spark, the current grows rapidly, and the potential as quickly falls away, the time between the first and second spark being that required by the p.d. to cover the distance from the auxiliary spark-gap to the plug. The author then arrives at the following conclusion: The true function of the auxiliary gap seems to be a means of allowing the secondary p.d. to grow to such a value that when the discharge takes place it is so sudden and so considerable in amount that the poorly conducting leakage layer on the plug is not able to deal with it all, and thus sparking takes place at the points of the plug. At the same time he mentions three conditions under which auxiliary gaps can be used with most benefit. (1) The gap must be larger than the gap on the plug owing to the latter working under the cylinder compression pressure. (2) It should be as near the sparking plug as possible. (3) It should not be larger than necessary. The best values for all these conditions can easily be found by experiment, and in practice there is a considerable range within which satisfactory results can be obtained. In any case the author considers the introduction of a spark-gap improves the ignition. A very clearly illustrated description of a simple hydraulic analogy is included. L. H. W.

831. *Vulcan Trembler for Ignition Coils.* (Motor Car Journ. 4. p. 386, Feb. 21, 1908.)—Many ordinary trembler coils are incapable of giving a satisfactory spark at motor speeds exceeding 1,000 r.p.m. The "Vulcan" trembler allows a motor to be run at 5,000 r.p.m. without "missing." The number of ruptures of the circuit given by this apparatus is approximately 450 per second. The actual trembler blade is of steel and is fixed at one end. Its free end, which is furnished with a platinum contact, vibrates in response to the impulses given by the coil, but the second platinum contact is mounted on a subsidiary flat spring and blade. M. O'G.

Digitized by Google

AUTOMOBILISM.[1]

832. *Hautier Petrol Cars.* (Locomotion Automobile, 9. pp. 792–794, Dec. 11, 1902.)—These cars are fitted with motors of the following sizes: 7 h.p., one cylinder; 18 h.p., two cylinders; 18 h.p., four cylinders. This article describes the 18-h.p. car. The cylinders are cast with the combustion-heads in pairs, all the valves being mechanically operated and interchangeable. Regulation is automatic and acts progressively on the duration of the lift of the valves and not on the height of the lift, thus securing uniform compression, whatever the volume of mixture admitted. The flywheel is placed in front of the motor and has vanes cast in it to act as a fan sucking air through a circular radiator placed just in front of it. The pump is mounted direct on an extension of the main axle. The cranks of the two inner cylinders are, contrary to the usual practice, 180° apart. Transmission is by metal to metal clutch, gears which are always in mesh, and jointed tail-shaft to live axle, but this size is also made with the usual side chain drive. The irreversible steering has an arrangement for taking up backlash.

L. H. W.

833. *Darcelle Petrol Car.* (France Automobile, 7. p. 826, Dec. 21, and pp. 836–839, Dec. 28, 1902.)—Both the motor and the transmission in this car present some uncommon features. The motor has four cylinders cast in one piece. These are arranged so as to form two transverse pairs, thus taking up no greater length of bonnet than a two-cylinder motor. The crank-shaft has only two cranks, both the connecting rods of each transverse pair of cylinders working on the same crank-pin, the head of one being of special shape and located between the other, which is forked to receive it. Owing to the speed at any instant of the two pistons not being the same, there is practically no dead centre point. Lubrication of the crank-pins is specially provided for by a curved pipe from each head dipping into a constant level trough of oil at the base of the crank chamber, the pressure of the oil in the pipe increasing with the speed of the motor. Transmission is by sliding gears, jointed tail-shaft and bevel-gear, on the usual lines, to a cross differential shaft which is, however, situated behind the rear wheel axles and on the same level. Each rear wheel has an independent live axle and large spur wheel with outside teeth, the power being transmitted to these from pinions on the differential shaft, which latter, when displaced, moves concentrically with the rear wheel axles. Numerous illustrations of the motor, chassis and the differential shaft are given. L. H. W.

834. *Tony Huber 20-H.P. Petrol Motor.* (Locomotion Automobile, 10. pp. 262–265, April 23, 1903.)—In this motor the valves are all mechanically operated, and situated on the same side of the four cylinders. These latter are all separate, and provided with corrugated copper tubes shrunk on to form the water-jacket. The combustion heads are separate castings. The cylinders are 112 mm. bore and 140 mm. stroke. Normal speed 1,200 r.p.m., capable of being varied from 300–1,800 r.p.m., at which latter speed the motor gives 35 h.p. The cranks are 180° apart and, as in the Renault motor, the two inner ones, one on each side of a central bearing, are set at the same

[1] Electric Automobiles are described in the Section dealing with Electric Traction.

Digitized by Google

angle and the two outer oppositely. A centrifugal governor acting on the inlet is provided, but later models are to be provided with a hand regulator varying the lift of the exhaust valve as well. The weight complete is 100 kilos. L. H. W.

835. *Decauville Cars: 1903 Type, 16-H.P.* **Vétéran.** (France Automobile, 8. pp. 104–106, Feb. 14, and pp. 122–124, Feb. 21, 1903.)—The "sheeted chassis" is the most noteworthy feature of this car. The frame consists of two longitudinal and three transverse channel irons, the space for the motor between the front and middle transverse channels being completely covered in on the underside by a steel plate 2 mm. thick stamped into the shape of a trough. In the bottom of this trough an opening of suitable shape is left, into which the lower half of the casting, constituting the crank chamber fly-wheel and change-speed gear casing, is fitted and bolted through a suitable flange to the steel plate. The whole of the working parts of the motor are thus protected from dust and dirt and, at the same time, a very simple rigid and light frame is obtained. The weight of the steel trough in the 16-h.p. car is about 16 kilos. The car is fitted with a four-cylinder engine, all valves being mechanically operated. Coil ignition is used and a small dynamo fitted which constantly re-charges the accumulators. The transmission is through a cone clutch and cardan jointed tail-shaft to a bevel differential gear live axle. The live axle sleeve carries the driving wheels, so that the axle itself has no bending stress on it, but is solely in torsion. All working parts have been arranged with a view to easy dismantling. Detailed description of all parts of the car with good illustrations are given, together with concise directions as to dismantling any parts. [See also Abstract No. 1210 (1902).] E. H. C.-H.

836. *Aultman Lorry and other American Steam Lorries.* (Automotor Journ. 7. pp. 900–902, Dec. 27, 1902.)—This article describes and illustrates the Aultman lorry, which is confessedly experimental in type. It has a 16-h.p. engine which drives all the four wheels by a complicated arrangement of friction discs, chains and bevel gear, and is built for loads of 5 tons. Another lorry described much resembles the Thornycroft wagon in shape and size. This is made by the Morgan Motor Co. The interior of the engine cylinders is not directly lubricated, so that the exhaust steam can be condensed and used over again without special precautions. The third vehicle described, the Spencer delivery wagon, is not really a lorry, the total weight being only 2,100 lbs. and the load only half a ton. It has a 6-h.p. four-cylinder single-acting engine and a water-tube boiler. L. H. W.

837. *15-H.P. Charron-Girardot-Voigt Car.* **L. Fournier.** (Locomotion Automobile, 10. pp. 6–9, Jan. 1, 1903.)—In this 1903 model, the tubes of the chassis are replaced by metal-faced wood. The two hind wheel springs are attached at the rear to a fifth (transverse) spring. The motor has four separate cylinders cast with heads complete, a regulator on the exhaust, extra large exhaust pipes, and mechanically operated valves, which are easily inspected, placed on opposite sides of the cylinders for the inlet and exhaust respectively. The unscrewing of a single nut enables any of the branched inlet pipes to be removed, exposing two inlet valves. Otherwise, the car follows very much the Panhard lines, though numerous special devices and refinements are described, for which reference must be made to the original article, which contains illustrations of the chassis, motor, carburettor and change-speed gear.
L. H. W.

Digitized by Google

838. *Nice Speed Races.* (Automobile Club Journ. 5. p. 427, April 16, 1903.)—

Mile course, 1,609 metres, standing start.

I.—Cars.

Car.	Mile. Secs.	Kilometre. Secs.
Mercedes	63¾	32·8
—	64·3	33
Mors	65·32	33·53
Gardner - Serpollet	66·26	31·53
Mercedes	67·25	33·09
Mors	67·95	33·24
—	68·56	35
Mercedes	69·62	35·6
Mors	69·79	33·58

II.—Voiturettes.

Darracq	68·2	35·28

III.—Motor Cycles.

Griffon	76·95	36·65
Griffon	96·41	55·40

1 kilometre flying start.
Open for all vehicles from 650 to 1,000 kg.

	Secs.
Gardner-Serpollet	29·19
„ „	30·55
Mercedes	32·30
Mors	32·66
Mercedes	33·63
Mors	33·64
Mercedes	33·85
„	33·96
Mors	34·66
Mercedes	34·96
Mors	35·50

1 kilometre flying start, and 600 metres for all cars with explosion engines.

	Secs.
Mercedes	31·76
„	31·90
„	32·73
„	32·89
Mors	33·2
Mercedes	34·81

G. W. de T.

839. *Delagneaux Extensible Pulley.* **L. Fournier.** (Locomotion Automobile, 9. pp. 710–712, Nov. 6, 1902.)—This article describes, with illustrations, a form of extensible pulley which may be used for automobile purposes. The crown is made up of a number of exactly similar pieces, and the method of increasing or decreasing the diameter of the pulley can be most easily understood by comparing it to two umbrellas placed near together, with their handles outwards, the ribs of the umbrellas being supposed to represent the spokes; thus by pressing together the rings holding the ribs, the umbrellas are opened. In the same way, by pressing together the rings (themselves capable of sliding on the shaft) which hold the spokes, the diameter of the pulley is increased. The feature is that, whatever the diameter, the pulley rim retains its circular form. For the details of construction, reference must be made to the original article. L. H. W.

840. *Simplex Variable Speed Gear.* (Motor Car Journ. 5. p. 42, March 21, 1903.)—To gradually vary the speed of a shaft while continuing to transmit power between the extreme limits 1 to 20, is effected by a gear made by the British Simplex Gear Company, consisting of two drums, each having a series of small, toothed pinions mounted on roller clutches and supported on small cross-arms which are capable of moving along radial slots cut in the sides of the drum. The radial movement of the pinions is effected by rotating two scroll plates. A rack is moved forward or backward to cause the scroll plates to rotate in the required direction. Its adaptability to motor-car work is noted. M. O'G.

Digitized by Google

841. *Motor-Car Lubrication.* **T. Clarkson.** (Automobile Club Journ. 5. pp. 132–135; Discussion, pp. 135–137, Feb. 5, 1903. Paper read before the Automobile Club of Great Britain and Ireland, Jan. 30, 1903.)—The friction between two surfaces sliding together depends upon: (1) The pressure applied to them; (2) the material of the surface; (3) their smoothness and hardness; (4) their wetness and dryness; (5) their temperature; (6) the viscosity of the lubricating medium. The law that friction is independent of the extent of surface in contact needs qualification, for if the surface is large, the pressure per unit area may be insufficient to squeeze out the film of lubricant, but with relatively small wearing surfaces, the pressure may squeeze out the lubricant and permit contact which may become so intimate as to start "scoring" or tearing of the surfaces. A common arrangement of lubricators is for a pump to deliver the oil into a distributing main fitted with branch pipes which connect with the several bearings. The objection to this is that some of the branch pipes may become fouled after prolonged use, and the rest of the branches will obligingly take the blocked pipe's share; hence the author designed a system by which the pump alternately works in full force on each pipe in turn, by means of a simple rotary valve closing all other pipes. M. O'G.

842. *Legros Cardan Transmission Arrangement.* (Locomotion Automobile, 10. pp. 73–74, Jan. 29, 1903.)—This is a description of a double-jointed tail-shaft for automobiles, which has several points of interest. The forward joint, which is spherical externally, is placed inside an extension of the change-speed gear-case. This spherical portion is supported by two exterior hemispherical pieces, an extension of one of which holds the ball-race for the tail-shaft. The hemispherical supports are contained in a cylindrical case, from which two rigid tubes are led to the top and bottom of the rear axle gear-case respectively. Whilst leaving the greatest freedom for motion of the rear axle in the vertical plane, this neutralises any tendency on the part of the case to rotate when the brakes are suddenly applied, and for this reason it is preferred to take off the torsional strain of braking from the tail-shaft, by putting the brake drum as near the rear axle bevel pinion as possible. L. H. W.

843. *Motor Boats using Producer Gas.* **K. Bräuer.** (Motorwagen, 5. pp. 348–350, Dec. 15, 1902, and 6. pp. 5–10, Jan. 15, 1903.)—A description of some canal boats fitted by the Gasmotorenfabrik Deutz with internal combustion engines of the ordinary stationary type for propulsion purposes. The article, which is well illustrated, deals first with a barge, the *Haldy II.*, having three screws, one of which is central and hinged, enabling it to be raised or lowered by means of a screw winding arrangement. The side screws are placed high up, and are alone used when the barge is loaded, the central screw being idle and raised to its highest position. When empty, on the other hand, the side screws are quite out of the water and the central screw lowered and used for propulsion. The engine is a horizontal oil engine of 16 h.p., using benzine, giving, with a useful load of 270 metric tons, 3·4 km. per hour. The engine is placed longitudinally in the centre of the boat, and drives, by a belt, a transverse countershaft, this driving, by bevel gear, the two side screws. The blades of these screws are pivoted, and can be turned by a hand wheel so as to act in the reverse direction for going astern. When it is desired to work the central screw, the belt is shifted on to another pulley. Another barge, the *Haldy I.*, having only the central hinged screw, driven in

Digitized by Google

the same way, is fitted with a similar sized engine using producer gas. The construction of the gas generator is similar to that in use for stationary purposes and has already been described in the Motorwagen, No. 14, 1902. With this generator, the time from first lighting up to starting the engine is only 30 min., a full charge of the generator lasting 5 to 6 hours. All danger of explosion is excluded by the partial vacuum in the gas supply pipe. Two other types of boats, fitted with more powerful engines, are described. A detailed description of the regulating arrangements is then given, for which reference must be made to the original paper. The writer is hopeful for the future of this method of propulsion, owing (1) to the small space required, the cargo space being diminished by only 6–8 per cent. as against 15–20 per cent. for a steam engine and boiler; (2) the high thermal efficiency, 24–26 per cent. compared with 8–9 per cent. for steam engines; (3) the little attention required, and low working costs which, in the case of the *Haldy I.*, work out at 15–20 pfennig per barge km., or 0·075 pfennig per (metric) ton km.

L. H. W.

844. *Experiments with Aeroplanes.* **L. Fournier.** (Locomotion Automobile, 10. pp. 86–88, Feb. 4, 1903.)—A few notes are given of experiments with aeroplanes carried out by Ferber, of Nice. The four machines first tried had only one plane, the passenger being supported from its underside. The longest flight attained was only 15 m., starting from a scaffold 5 m. high. The fifth machine, made with the help of O. Chanute, of Chicago, consisted of two superimposed planes, having an area of 83 sq. m. It weighs 50 kilos, is 9 m. long and 1·8 m. high. This machine has achieved a flight of 150 m., starting from a height of 25 m. E. H. C.-H.

845. *Recent Aeronautical Accidents.* **G. Espitallier.** (Génie Civil, 42, pp. 7–10, Nov. 1, 1902.)—The author discusses the two principal recent aeronautical attempts which have ended disastrously, and seeks to indicate the causes of failure and the lessons to be derived therefrom. He comes to the conclusion that both accidents were due to faults of construction, which had often been pointed out as dangerous, and to the manner in which previous experience was ignored, and suggests an extended apprenticeship to ordinary ballooning, as affording the best preliminary training, before proceeding to attempt other forms of aerial navigation. L. H. W.

REFERENCES.

846. *Richmond's and Brown's Surface Condensers.* (Mech. Eng. 11. pp. 14–15, Jan. 3, 1903.)—These articles describe two new arrangements of surface condenser for steam, and give sectional illustrations. Both have the circulating water inside the condenser tubes, and have the steam admitted at right angles to these. They differ in the methods of circulating the water and removing air from the condenser.

F. J. R.

847. *Defective Indicator Diagrams.* **A. M. Arter.** (Mech. Eng. 11. pp. 123–127, Jan. 24, 1903. Paper read before a meeting of the Civil and Mechanical Engineers Society, Jan. 8.)—It consists mainly of a collection of defective diagrams, the distortion being due to faults in the indicating apparatus and not to bad distribution of the steam, taken chiefly from torpedo-boat destroyer engines running at about 380 r.p.m., the fault in the apparatus which produced each distortion being traced and stated. H. R. C.

Digitized by Google

848. *Recent Progress in Large Gas Engines.* **H. A. Humphrey.** (Engineering, 74. pp. 373, 375–378, Sept. 19; 426–428, Sept. 26; 442, 443, and 458–460, Oct. 3; and pp. 519 and 520–523, Oct. 17, 1902. Paper read before the British Association (Section G.) at Belfast, Sept. 11.)—The author describes, with the aid of numerous illustrations, various types of large gas engines which have been recently constructed. G. W. DE T.

849. *Motive Power from Blast-furnace Gases.* **B. Donkin.** (Inst. Civil Engin., Proc. 148. pp. 2–31; Discussion, pp. 32–57, 1902.)—The author summarises the progress which has been made in the application of waste blast-furnace gases to driving gas engines. An appendix contains useful tabular results of tests of gas engines working with these gases. G. W. DE T.

850. *Higher Power-limit of Benzine Motors for Automobiles.* **H. Güldner** (Motorwagen, 5. pp. 188–191, June 30, 1902.)—The author criticises R. Conrad's paper, "Relation between Speed and Torque of the Protos Motor" [see Abstract No. 1770 (1902)], and shows that a motor of this class, working at the rate of 4·93 b.h.p., will consume at least 1·95 kg. of benzine, of which 0·79 kg. is lost by incomplete combustion. C. C.

851. *Alcohol Engines Exhibited in Berlin, 1902.* **R. Schöttler.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1157–1162, Aug. 2, and pp. 1223–1230, Aug. 16, 1902.)—The author discusses the relative merits of alcohol, benzine, and petroleum, and describes a large number of alcohol engines. C. C.

852. *Elasticity of Belts made from Various Parts of the Hide.* **C. Bach.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 985–989, July 5, 1902.)—The author describes his experiments and gives the results in tables and curves. C. C.

853. *Traction of Road Vehicles.* (Engineering, 74. pp. 456–458, Oct. 3, 1902.)—This is a description of a new dynamometer constructed for the British Association Committee on the Resistance of Road Vehicles to Traction. C. C.

854. *Construction of the Normal and Circle of Curvature to the Pole-curve of the Four-cylinder Chain.* **W. Hartmann.** (Zeitschr. Vereines Deutsch. Ing. 46. pp. 1361–1363, Sept. 6, 1902.) C. C.

855. *Clément Voiturette.* **L. Fournier.** (Locomotion Automobile, 9. pp. 726–727, Nov. 13, 1902.)—A description of this small car with photograph, plan of chassis and diagram of ignition and water-cooling arrangements. [See also Abstract No. 152 (1903).] L. H. W.

856. *An Automatic Carburettor for Explosion Engines.* **A. Krebs.** (Comptes Rendus, 135. pp. 894–897, Nov. 24, 1902.] C. C.

857. *Transmission Gear of the Toledo Gasoline Touring Car.* (Horseless Age, 10. pp. 305–306, Sept. 17, 1902.)—The gear is described and illustrated. [See also Abstract No. 153 (1903).] C. C.

858. *Automobile Balloons.* **G. Wellner.** (Motorwagen, 5. pp. 177–180, June 15, 1902. Paper read before the Oesterreichischen Ingenieur u. Architekten-Verein.)—This paper contains a table with details of some motor-propelled balloons. C. C.

Digitized by Google

859. *Entropy Analysis of the Otto Cycle.* **S. A. Reeve.** (Amer. Soc. Mech. Engin., Trans. 24. No. 0962. pp. 1–11, 1902.)—The author calls attention to the advantages of submitting all heat-engine records to the entropy analysis, especially in the case of tests of gas engines of the Otto type; he also converts the indicator-cards published in vol. xxii. of the Trans., pp. 157–162, into entropy-temperature diagrams, some of which are reproduced in the paper. C. C.

860. *Adiabatics of Wet Steam.* **F. Foster.** (Engineer, 95. p. 358, April 10, 1903.)—If $pv^n = \text{const.}$ is taken as the equation of an adiabatic, n cannot be specified merely by the dryness of the steam; it depends, further, on some other magnitude, such as the temperature at which the steam is absolutely dry. R. E. B.

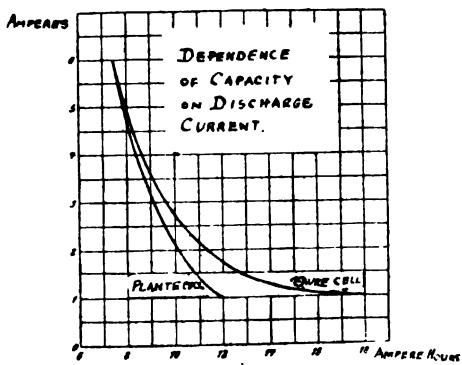
861. *German Lorry with Direct-driven Rear-axle.* **E. Valentin.** (Motorwagen, 6. pp. 87–90, March 15, and pp. 112–115, April 15, 1903.)—This is a description of a lorry built by the Berliner Motorwagen Fabrik, weighing 1,800 kg., and intended for loads of 1,500–2,000 kg., with an admissible overload up to 2,600 kg. The motor, which uses alcohol only, has two cylinders 120 mm. bore, 140 mm. stroke, and gives 10 h.p. Four speeds are provided and a device for cutting out the top speed, if desired, so that the driver cannot go fast within the town limits. The chief feature is the specially strong bevel drive to the live rear axle, which is very fully described and illustrated. L. H. W.

862. *American Type Diesel Engine.* (Elect. Rev. N.Y. 41. pp. 762–763, Dec. 6, 1902.)—Whatever the size of the engine, the consumption of fuel will not exceed 0·5 to 0·6 lb. of oil per b.h.p.-hour when running within its economical range. A three-cylinder engine has been erected at the Corliss steam-engine works at Providence, and has operated these works for the past six months, showing an economy of 70 per cent. in fuel consumption as compared with coal. Texas crude oil is used. [See also Abstract 1588 (1902).] C. C.

Digitized by Google

INDUSTRIAL ELECTRO-CHEMISTRY AND GENERAL ELECTRICAL ENGINEERING.

863. *Accumulator Tests.* **M. U. Schoop.** (Elektrotechn. Zeitschr. 24. pp. 214–218, March 19, 1903.)—The author begins by criticising the usual guarantees asked for when purchasing accumulators, among which, reference to the internal resistance of the cell is the exception, whereas, in certain cases, as in batteries for load-equalising purposes, an accurate knowledge of the ohmic resistance is of great importance, standing as it does in close relationship to the boosting effect. Only recently it has become more usual to stipulate beforehand the maximum potential fall allowable when the battery has been charged at maximum charging rate for a definite number of seconds and immediately afterwards discharged at the 1-hour rate for the same length of time. He instances, as an example of this, the Akkumulatorenfabrik A.G., who guarantee with their cells GS 21 to GS 84 that, for a discharge lasting ½ min. at the 1-hour rate and a 1-min. charge at the same



charging rate, the range of p.d. will be between 1·89 and 2·23 volts, with a maximum departure from this of ± 4 per cent. The author then describes experiments carried out to decide the relative merits of formed and pasted plates, using for this purpose a modification of Uppenborn's Kohlrausch method of opposing the two test cells. The cells used were made up of plates having at the 1-hour discharge rate the same capacity down to the same p.d., and differing from one another solely in the one having a formed positive and the other a pasted positive plate. The negatives were in both cases of the same construction and chosen of the same capacity, but possessing, relative to the positive plates, a large excess of capacity, so that the p.d. curve of the cells practically depended solely on the state of the positives. After several charges and discharges, the acid was replaced by fresh acid of 1170, and the tests then begun. The data as to positives used are: Dry formed plate, weight 600 gm., size in cm., 10 by 12 by 0·7; pasted plate, weight 570 gm., size in cm., 12 by 12 by 0·6. With 6 amperes discharging current, the capacities were equal, but with slower discharge rates, the Faure cell utilised more and more of its active material, and at 1 ampere the capacities were already only as 2 : 3, as will be seen by the accompanying

Digitized by Google

curve. Curves are also given from the e.m.f. and p.d. readings. The author then deals with the question as to which plate is the more suitable for buffer batteries, and gives curves embodying the results of further experiments which are fully described in the paper. From these he draws the conclusion that with formed plates the diffusion of the acid takes place more easily than with pasted plates (in the experiments described, the steady state of acid inter-diffusion from start of discharge took place in 10 min. and 50 min. respectively), so that with heavy discharges, the active material can be more fully utilised in the former than in the latter, but this is counterbalanced by the fact that the internal resistance of a pasted plate cell of the same capacity, acid strength, and plate separation is less than that of a cell with formed plates, and that therefore, from the buffer battery point of view, the pasted plate is undisputably superior. [See also Abstract No. 2156 (1902).]

L. H. W.

864. *Pasted Electrodes for Accumulators.* **E. Leimer.** (Centralblatt Accumulatoren, 4. pp. 50–52, March 1, and pp. 61–65, March 15, 1903.)—This article gives the results of tests of active materials prepared by mixing lead oxide with the following solutions respectively : (1) Pure water ; (2) dilute sulphuric acid, sp. gr. 1·170 ; (3) dilute sulphuric acid, 1·120 sp. gr. mixed with glycerine ; (4) alcoholic extract of cobbler's wax ; (5) amber dissolved in carbon disulphide ; (6) gelatine dissolved in water ; (7) solution of phenol in water ; (8) solution of salicylic acid ; (9) solution of acetic acid ; (10) solution of pyridine in water. Each paste was compressed in a mould to the shape of a flat cake ; removed after setting and dried for 30 hours in a current of hot air at 150° C., then soaked in dilute sulphuric acid, sp. gr. 1·075, for 60 hours, and afterwards drained and dried at 100° C. Each cake next had a lead frame cast round it and was formed as a positive in dilute acid, after which it was discharged and recharged alternately until ultimately it broke down from one cause or another and was eliminated from the test. After the electrodes had attained to their maximum output (at the end of 7 cycles of working), portions of active material were removed from each and, after drying, ground to cubes of exactly 1 cm. side, which were tested for electrical conductivity and mechanical strength. Comparative figures of the behaviour of the different electrodes as regards loss of material, output, life and other properties are given. As a result of his experiments, the author divides all binding solutions for pastes into two classes : First, those in which the lead oxide particles are united by the direct cohesive properties of the liquid used, such as Nos. 4, 5, and 6 above ; second, those in which chemical reaction gives rise to a basic lead salt which is the real cementing agent, as was the case with the other solutions. He further considers that those of the latter class must necessarily give much superior results, and the reasons therefor are discussed at some length.

E. J. W.

865. *Electrolytic Nickel Refining.* **T. Ulke.** (Electrochem. Ind., Philadelphia, 1. pp. 208–212, Feb., 1903.)—The author deals with the historical development and present position of this industry. Vivian's Nickel Refinery was started at Swansea in South Wales in 1892, and stopped in 1894. The plant was designed for the treatment of 10 tons of copper-nickel alloy per week, the anodes being composed of 60 per cent. Cu and 40 per cent. Ni. A solution of copper sulphate was employed as electrolyte, and it was intended to deposit the whole of the copper and to work up the remaining solution by chemical methods for nickel or its salts. It was found, however, that this

Digitized by Google

method of working the process was impracticable, and the last traces of copper had to be removed from the solutions by the aid of sulphuretted hydrogen. The Balbach Nickel Refinery, U.S.A., was started in 1894, under the direction of F. A. Thum, and ceased operation in 1900 owing to the cessation of the supply of anode material by the Orford Copper Company.

The electrolytic method used at this refinery was described by Foerster in the Zeits. f. Elektrochemie in 1900. The raw nickel used for the anodes in this process contained 94 to 97 per cent. Ni, and was obtained from the oxide by ordinary metallurgical methods. The Orford Company, who formerly supplied this metal to the Balbach Company for electrolytic treatment, have now improved their methods of extraction, and produce nickel testing 99·2 per cent. Ni, by the metallurgical process. Details of the processes used or about to be tried, at the Cleveland Nickel and Copper Refinery (Browne's patent), at the Hamilton Nickel and Copper Refinery (Hoepfner & Frasch patents), at the Papenburg Nickel and Copper Refinery (Hoepfner patents), and at the Sault Sainte Marie Nickel and Copper Refinery, are also included in this article. For the latter refinery (now being erected) Ulke recommends a combination of his own and Thum's patented processes. [See also Abstract No. 921 (1901).] J. B. C. K.

866. *Electrolytic Separation of Nickel and Copper from an Alloy obtained from Magnetic Pyretic Ores.* **E. Günther.** (Zeitschr. Vereines Deutsch. Ing. 47. pp. 574–579, April 18, 1903. From an Inaugural Dissertation by the author before the Tech. Hochschule, Aachen.)—The author records the results obtained in a series of experiments carried out with an alloy containing 26 per cent. Cu, 50 per cent. Ni, and 21 per cent. Fe, with sulphur and carbon as impurities. The iron was purposely left in this alloy in large amount, and neither the iron nor the sulphur caused difficulties in the electrolytic separation. The following scheme of treatment was adopted in the author's experiments: I. Solution of the alloy. The alloy was employed as anode in the bath. All the metals passed into solution, the copper being deposited at the kathode, while the iron and nickel remained in solution. II. Separation of the last traces of copper from the solution obtained from I. The production of a pure nickel salt solution by removal of the iron. III. Treatment of the solution obtained in II. for production of metallic nickel. Copper testing 99·97 per cent., and nickel testing 99·90 per cent. were obtained by electrolysis in the author's experiments, but no figures are given in the extract for the percentage of the original metals present in the alloy, which were recoverable in this way. J. B. C. K.

867. *Electrolytic Copper Refining; Progress in* 1902. **T. Ulke.** (Eng. and Mining Journ. 75. pp. 408–409, March 14, 1903.)—Two tables contain the chief information of this Report. The first gives details as to the names, localities, power plants, refining vats, and outputs of the ten electrolytic copper refineries situated in U.S.A., and the second contains similar information respecting the European refineries. These are located as follows: Great Britain, 6; Germany, 9; France, 4; Austria-Hungary, 2; Russia, 2. As regards output, the author summarises his information as follows: The world's average daily production of electrolytic copper is about 883 short tons, of which 764 tons, or 86·5 per cent., are supplied by the United States. Of the balance of 119 tons daily production, or approximately 13·5 per cent., Great Britain furnished a little over 8·8 per cent., Germany about 2·75 per cent., and France a little over 1·6 per cent. The United States now produces

Digitized by Google

annually at the enormous rate of 278,860 tons of electrolytic copper, which at $260 per ton, is valued at $72,503,600. The by-products recovered daily contains about 741,100 ounces silver and 948 ounces gold, which equals an annual output of over 27,000,000 ounces of silver, valued at nearly $13,000,000, and more than 250,000 ounces of gold, valued at $5,167,500. [See Abstract No. 921 (1901).] J. B. C. K.

868. *Physical Characteristics of Electrodeposited Metals.* **W. McA. Johnson.** (Electrochem. Ind., Philadelphia, 1. pp. 212–214, Feb., 1903.)—After giving a short account of Nernst's concentration cells, the author discusses the question of the use of double salts in electroplating. The value of these double salts depends on the formation of complex ions; it needs a higher e.m.f. for depositing the metal, and the ions are hurled out of the solution under great pressure and thus form a compact and dense deposit. Also the "katholyte" does not become impoverished of kations so readily as it would if a single salt were used, since the complex ions break down to furnish new kations as fast as these are deposited. The necessity of determining the "electrode voltage," *i.e.*, the potential of the electrode against a normal electrode, as distinguished from terminal voltage, is very strongly emphasised, as it is the former which is of use whenever trouble arises during electrodeposition. Cold solutions should be used in preference to hot, in order to prevent the formation of insoluble basic salts, although, in some cases, the latter are preferable, as for example in the case of nickel. The curling up of electro-deposited nickel is considered by the author to be due to unequal strains between the outside and inside layers; hot solutions and low electrode voltage tend to equalise these strains and thus prevent the curling. T. S. P.

869. *Tests for Galvanised Iron.* **C. Richter.** (Elektrochem. Zeitschr. 9. pp. 161–164, Nov., 184–186, Dec., 1902, and pp. 208–215, Jan., 1903.)—The author deals with the methods to be adopted in testing the coating of zinc upon iron, known under the trade name of "galvanised" iron. Galvanised iron was produced up to 1893 or 1894 solely by the "hot" or "dipping" method, and only in recent years has electrodeposition been employed in this industry. Richter states that the new process has not extended rapidly, and that the old "dipping" method of manufacture, in spite of its numerous disadvantages, still maintains its position in the industry. He considers this slow adoption of the electrolytic process as partly due to the lack of scientific methods of testing the zinc coating produced. In order to remove this obstacle to further progress, the author has drawn up the following list of properties and characteristics for which, in his opinion, the protective coating ought to be examined: (1) *Geometrical and Optical Properties*—Form, Colour, Lustre. (2) *Mechanical Properties*—Hardness, Continuity, Elasticity, Tensile Strength, Adhesiveness. (3) *Chemical and Electrochemical Properties*—Chemical Constitution, Resistance to Oxidation, Protective Power. (4) *Thermal Properties*—Coefficient of Contraction and Expansion. (5) *Properties of the Base Metal; usually Iron*—Any alteration in these due to the galvanising process to be noted. The methods to be adopted for determining each of these properties or characteristics are dealt with by the author with German thoroughness; and, in conclusion, he states that this work is merely preliminary to the formulation of a set of rules and methods for use by those engaged in the galvanising industry. J. B. C. K.

Digitized by Google

870. *Steel Production in the Electric Furnace.* **H. Goldschmidt.** (Elektrotechn. Zeitschr. **24.** pp. 65–66, Jan. 22, 1903. Paper read before the Elektrotechnische Gesellschaft at Cologne, Oct. 29, 1902.)—Last year the author was requested by the Patent Office to study on the spot the Stassano process [see Abstract No. 1128 (1900)] as in operation at Darfo, in Italy; he was especially to ascertain if it was really possible to obtain in the electric furnace, iron containing less than 0·2 per cent. of carbon. The report, which is accompanied by exact analytical, thermo-chemical and economic data is very favourable. With the special facilities (water-power, wood-fuel, &c.) at Darfo, it is possible to produce a ton of very pure iron at a cost of about 75 marks, so that for Italy, at any rate, the outlook is bright. The author is of opinion, however, that in Germany the process is not likely to compete with the present process for the preparation of ordinary steel, as this is produced there at less than 100 marks per ton. The Stassano process may have a future in Germany in the production of crucible steel which at present costs about 300 marks a ton. D. H. J.

871. *Siloxicon: a New Electric Furnace Product.* **O. E. Dunlap.** (West. Electn. **32.** p. 287, April 11, 1903.)—Siloxicon is a new electric furnace product, discovered by Acheson, of utility as a lining material for electric and other furnaces. It is made by heating ground coke and sand with or without sawdust, to a temperature of 4,000° to 5,000° F. The product is ground to pass a No. 40 sieve, and is packed for shipment in barrels. It is self-binding, and when moistened with water, can be moulded to any desired shape. If desirable, 25 per cent. of clay can be mixed with it. Siloxicon is insoluble in metals; is infusible at very high temperatures, and is inert towards both acid and basic slags. Crucibles made of this material are superior to those made of clay, or of a mixture of clay and graphite.

J. B. C. K.

872. *Experiments with a Pelton Wheel.* **W. C. Houston.** (Inst. Engin. and Shipbuilders, Trans. **46.** 8. pp. 15–26, April, 1903.)—Experiments were made with a wheel 11·4 in. in diameter with different nozzles under varying heads, to determine the various losses. The ratio between the potential energy due to the head of water, called the available water horse-power, and the actual kinetic energy in the jet, was found to vary with the size of nozzle, but, for any one size of nozzle, it was constant with pressures varying from 100 to 1,000 lbs. per sq. in. The following values were obtained :—

Diameter of nozzle. Inches.	Efficiency of nozzle.
0·0724	0·71
0·0835	0·80
0·1023	0·92

The other losses are those due to bearing and air friction, to the cups dividing the jet, to the edges of the cups interrupting the jet, and the residual energy in the water leaving the wheel. The frictional losses were determined by allowing the wheel to slow down from top speed, and calculating the resistance at any speed from the observed retardation and the calculated moment of inertia. The losses by cup friction, &c., were determined by taking the static couple, with the wheel fixed. The losses due to the edges of the cups are obtained by extrapolating the curve connecting brake readings

Digitized by Google

and speed—the difference between the extrapolated brake reading when the speed is zero and the actual statical couple represents this loss. The residual energy in the water is calculated from the angles of the cups.

A. E. L.

873. *Preliminary Heating of the Charge for Electric Furnaces.* **A. Minet** and **A. Neuburger.** (Elektrochem. Zeitschr. 9. pp. 139–142, Oct., 1902.)—Two kinds of electric furnaces are described. In the first, the upper portion above the electrodes is divided into three chambers, each of the latter being provided with a pair of tuyeres. Through the middle chamber coke is introduced, and air is blown through the tuyeres; this burns part of the coke, and the heat of combustion warms up the remainder. The two outside chambers contain the ore and the flux, and coal gas or water gas is blown through the tuyeres, thus heating up the mixture. The contents of the three chambers then come together on the hearth of the furnace. The cost is less than when the preliminary heating is brought about by the electric current. In the second furnace, the hearth is enclosed on both sides by a kind of two-chambered regenerator. These regenerators are heated by the combustion of the hot gases from the blast furnace. For high temperatures (about 1,500° C.), the hot gases are first passed through the outer chambers and then burned in the inner chambers by means of previously heated air. For lower temperatures (500° C.), the hot gases are passed through the inner chamber first and then through the outer ones. The hot gases from the blast furnace can also be used to warm up the regenerators and then be brought to the hearth of the electric furnace, and their reducing action utilised there.

T. S. P.

874. *Governing Exciter Turbine.* (Eng. News, 49. pp. 246–247, March 19, 1903. From the Wisconsin Engineer.)—For governing a small turbine driving an exciter for an alternator, an induction motor is employed. This limits the variation in speed to the slip corresponding to its full load either as motor or generator. By making it of the same power as the exciter, water may be shut completely off the turbine, the motor driving the exciter.

A. E. L.

875. *Switchboards for High Pressures.* **Benischke.** (Zeitschr. Elektrotechn., Wien, 21. pp. 149–154, March 15, 1903. Report read before the Vereins-Sitzung, Jan. 7, 1903.)—The paper reviews some of the modern developments of high-tension switchboard design. It points out the utility of reverse-current automatic cut-outs on high-tension feeders working in parallel. If a cable-charging device is decided on, a practice more usual in England than on the Continent, a special motor generator is advocated, owing to the practical difficulties of making a satisfactory high-tension water resistance suitable for charging purposes. R. C. R.

876. *Fuses for High-tension Mains.* **F. Probst.** (Zeitschr. Elektrotechn., Wien, 21. pp. 181–185, March 29, and pp. 199–204, April 5, 1903. Report read before the Elektrotechn. Verein at Vienna, Jan. 28, 1903.)—Two different kinds of fuses are now generally employed in high-tension networks, the one kind as a protection against too large an increase of the current, and the other type as protection against increased voltage. The first type of fuse consists chiefly in a piece of metal which melts if the current increases beyond a certain point. Great difficulties were experienced in introducing this type—

Digitized by Google

already widely used in low-tension network—on high-tension networks, as the melting metal produces vapours forming a conducting path for the current. Not only the tension, but, even to a greater extent, the amount of current which the system permits to flow on short-circuit, are of considerable importance as regards the effectiveness of the fuse. The author shows experimentally that a fuse which is quite satisfactory at short circuit for a 2·5-kw. transformer, may be useless for a 7·5-kw. transformer. He shows various means of overcoming these difficulties. Lead, the metal formerly most often employed for low-tension fuses, has sometimes been replaced by silver, which forms a smaller amount of vapour, or by an alloy (Britannia metal) forming vapours of low conductivity. Several types have been constructed with a view of breaking the arc formed by these vapours. The metal wire is put into a strong insulated tube, with the remaining part of the tube filled by a fine non-fusible sand; or the ends of the tube are open, so that the vapours can escape on both sides, thus blowing out the arc. The wire may be arranged so that, after melting, the ends of the fuses are drawn apart either by gravity or by springs. Another ingenious arrangement comprises two carbon balls fixed to the fuse wire, and so placed that, after the melting of the wire, the vapours press the balls against the two openings, thus smothering the arc. In extensive use are the horn fuses depending upon electrodynamic or electromagnetic phenomena. They are cheap and safe, and may be used with great advantage for large currents. The second type of fuse serves as a protection against an increase in the voltage. Increase of voltage may occur by atmospheric discharges, by resonance, by switching transformers upon networks of high capacity, or by the mere switching on and off of long-distance cables. The use of a melting wire is not desirable in these circumstances, since the interruption of the current is accompanied by the formation of a fluctuating arc and the attendant resonance phenomena. Instead of this wire, a spark-gap is arranged between the mains and the earth. Generally a metal plate with teeth cut in its edge is placed very near to another similar plate, thus making the resistance of the path through the air as small as possible. The use of horns in connection with these sparking-points has been proposed by G. Benischke and by P. Thomas. A simple apparatus constructed by the author is described, serving as a maximum current indicator. An iron ring is placed round the cable, the maximum current of which has to be measured, a piece of the ring being arranged to be movable. At high currents the ring is magnetised, thus attracting the movable piece, which may be adjusted by a spring, and calibrated so as to show exactly the maximum amount of current which has been attained. Another apparatus, invented by A. Lehotzky, is described, and its action shown experimentally. It serves as a protection for polyphase motors, where it might happen that by an increase in the load only one fuse would melt. H. M. H.

877. *Experiments with an Extra High-Tension Fuse.* **C. C. Garrard.** (Elect. Rev. 52. pp. 614–615, April 10, 1903.)—Circuit-breaking devices of the oil-break type are the only ones considered safe for extra high-tension circuits. The advantage of a fuse over an automatic switch is chiefly attributable to its introduction of the time element, its simplicity being a further recommendation. The experiments described were carried out with an oil-break fuse which was a development of the well-known Ferranti oil-break standard fuse. [See Abstract No. 271 (1903).] It consisted of a large porcelain pot 18½ in. high, having a central division piece, on which a porcelain saddle rested, dividing the pot into eight compartments. Contacts, projecting through the

Digitized by Google

back, conducted current into and out of the fuse. Two spindles were connected to these contacts, and each spindle carried a number of drums containing springs, and fitted with flexible copper tapes long enough to reach to the top of the bridge. The tapes were drawn up from each side, against the tension of the springs, and fuse wires stretched between their ends across the dividing partition, a good contact being effected by soldering. When the wires melted, the flexibles were released and drawn quickly under the oil by the springs.

By permission of the Metropolitan Electric Supply Company, tests were made at Willesden Station, and the Sulzer-Kolben 5,500-h.p., two-phase, 11,000-volt plant was used. The fuse, connected with an oil-break switch across one phase of the alternator, was fitted with 14 strands 28 LSG copper wire (giving a carrying capacity of 250 amperes). When the switch was closed, the phase was short-circuited through the fuse, which blew admirably, though a loud report was heard, and a cloud of smoke shot into the air.

The arc proved on examination to have been confined to one of the four parallel fuses, and the other wires were cut clean in two.

This action is advantageous in reducing the amount of vapourised metal in the arc, as only a quarter of the metal is vapourised in this case, as against the whole if the wires were bunched and fused together. The flash was not always confined to the same pair of flexibles, and a repetition of the tests was attended with similar results, no damage being done to the pot in any instance. [See also Abstract No. 1707 (1902).] W. E. W.

878. *Testing of Insulators.* **F. O. Blackwell.** (Amer. Inst. Elect. Engin., Trans. 20. pp. 421–425 ; Discussion, pp. 445–493, and 521–534, April, 1903.)—All insulating materials will withstand momentarily two or three times the pressure which they can carry continuously, though glass and porcelain are not affected in the same way as organic materials. The shape of the potential wave largely affects the test : with given volts on a voltmeter, the maximum instantaneous potentials may differ by two to one. Insulating materials show that their ability to resist puncture depends rather on the average than the maximum potential. The alternator used for testing should give a sine wave under all conditions, as this wave is generated by most long-distance transmission plants. The armature reaction should be as small as possible, and there should be considerable reluctance in the magnetic circuit. Only one transformer should be used to step up to the highest potential required. All insulators should be free from cracks, bubbles, or pits in which moisture can lodge. The glaze should cover all outer surfaces in porcelain insulators, dirt sticks to unglazed surfaces. Good porcelain insulators are absolutely non-absorbent of water, and should have a polished fracture like that of glass. A fair test for an insulator is to apply twice the potential, for which it is to be employed, between the head and the interior for one minute. New types of insulators should be tested, both wet and dry. The dry test is of little value ; the voltage at which an arc is formed can be determined beforehand by referring to a curve of arcing distances in air. In the wet test, water should be played on the insulator from a nozzle under a pressure of at least 50 lbs. to the sq. in. Insulators should also be tested for mechanical strength. W. H. S.

879. *Protective Clothing for High Voltages.* **N. Artemieff.** (Elektrotechn. Zeitschr. 24. pp. 210–211, March 12, 1903. Report read before the Elektrotechniches Verein, Nov. 25, 1902.)—An interesting contribution to the present

Digitized by Google

knowledge of the subject, though not convincing for practical purposes. The author considers that insulating the body with rubber leaves much to be desired, the risks and awkwardness for handling purposes increasing very much as the pressures to be dealt with become greater. He goes to the other extreme and makes use of a metallic-gauze jacket covering the head and hands. This method, firstly, prevents electrostatic discharges through the body, since it is well known that the lines of force will not penetrate through but confine themselves to surface of a metallic sheath. Secondly, unless the person stands on insulation, the jacket practically earths any article that is touched; and thirdly, it shunts or short-circuits the body. The underlying principle is that currents will take the easier path through the metal gauze and protect the body from a dangerous or paralysing shock, but at the risk of burning the skin. The author, however, seems to be of opinion that if an arc be formed to the jacket it can be broken before paralysis ensues. His jacket is made of very fine gauze, which therefore dissipates heat rapidly, and has a resistance of 0·002 ohms from hand to hand. With the jacket on he demonstrated, among others, the following experiments with a 50 ∿, 170-kw., 150,000-volt transformer, giving a sparking distance of about 35 cm. Standing insulated and uninsulated, he drew spark discharges from one pole and from both poles, the current in the latter case sparking from one pole to one elbow, passing through the jacket and sparking from the other elbow to the other pole. Connecting the jacket to one pole of the transformer, he drew discharges from the other pole, standing insulated in the middle of a glass slab. He concludes that his experiments at 50 ∿ are not very different from those of Tesla with higher frequencies. In no experiment were the transformer terminals short-circuited by the jacket. R. C. R.

REFERENCES.

880. *Hazen and Williams' Hydraulic Slide Rule.* (Eng. Record, 47. pp. 321–322, March 28, 1903.)—A description, with examples, of the uses of this rule in hydraulic engineering. By its aid computations of velocity, quantity, friction, &c., may be performed. J. W. P.

881. *Recent Electrical Design.* **W. B. Esson.** (Inst. Elect. Engin., Journ. 32. pp. 329–361; Discussion, pp. 429–469, March, 1903.)—A review of the tendencies of recent design in Great Britain and abroad. [See also Abstract No. 974 (1902).] A. E. L.

882. *Hydro-Tachymeter.* **L. Ribourt.** (Génie Civil, 42. pp. 297–300, March 7, 1903.)—In this article, the author gives a detailed description of the hydro-tachymeter, invented by him, and explains its application for quickly regulating the speed of hydraulic turbines, this being an essential condition in driving dynamos to generate electricity for power and lighting purposes. The results of several trials made with this system of regulation have been very successful. The article is fully illustrated, showing the tachymeter and its application to turbines acting with either high or low heads. Several interesting diagrams accompany the article. L. G.

883. *Portable Electric Drill.* (Engineering, 75. pp. 565–566, April 24, 1903.)—This article describes the construction of a drill manufactured by Campbell and Isherwood, of Bootle. Drawings are given. The motor drives a hollow shaft, through which is passed a sliding shaft, the two being connected by means of a key on the hollow shaft, a slot running nearly the whole length of the hollow spindle. At the end of the hollow shaft the drill is mounted, the speed being twice reduced by means of bevel wheels. W. H. S.

Digitized by Google

GENERATORS, MOTORS, AND TRANSFORMERS.

884. *Design of Continuous-Current Dynamos.* **H. A. Mavor.** (Inst. Elect. Engin., Journ. 32. pp. 478–484; Discussion, pp. 484–497, March, 1903.)—The author gives a number of formulæ for determining the core and tooth losses, radiation from the surface of the core, and watts generated by the machine, its output and efficiency. He assumes hysteresis and eddies in the core and hysteresis in the teeth, proportional to n, eddies in the teeth proportional to n^2, radiation proportional to $\sqrt{n}$. He shows that for every machine there is a maximum possible output for a given rise of temperature, and that this maximum is at a definite speed of rotation. The total watts and efficiency are greater for a low speed with a deep slot and high induction, and for a high speed with a shallow slot and high induction. *Discussion.*—**M. B. Field** thought radiation should be expressed as $\alpha + \beta\sqrt{n}$, and that eddies in the core should be taken as proportional to n^2. He pointed out that if the armature is short-circuited at very low speed the C^2R loss will equal the total permissible armature loss, or if it is open-circuited and run at a very high speed, the iron loss will equal the total permissible loss, the output in each case being zero. Between these speeds the output rises to a maximum and decreases again. He objected to the way some firms were standardising enclosed motors. They took a 20-h.p. open motor and rated it at 15 or 10 h.p. enclosed, without modification. The proportion of iron to copper loss could not be the best in each case. **W. A. Ker** said the practice of his company was to enclose their ordinary open motor, and run it at a lower rating at a lower speed. By reducing the speed from 1,000 to 900 with a smaller current, it is possible to add at least one turn to each commutator section without increasing the reactance voltage. He thought that the watts radiated should be proportional to the speed. **W. B. Hird** thought that, within ordinary limits of speed, the formula $\alpha\sqrt{n}$ might express the watts radiation just as well as $\alpha + \beta\sqrt{n}$; and that it was sufficiently accurate to take the core eddies as a percentage of the core hysteresis, except at very high speeds. The **Author,** in reply, said it was necessary in small machines to consider the speed at which the machine had to run with special reference to the iron losses. His method was to plot the watts radiated at each speed with the iron losses. He agreed that it might be better to plot the curves of watts radiated, as Field suggested. [See also Abstract No. 974 (1902).]

R. B. R.

885. *Electromechanical Governing and Compounding Electric Generators.* **Routin.** (Soc. Int. Élect., Bull. 2. pp. 678–704, Aug.–Sept.–Oct., 1902.)—The author refers to the fact that with ordinary governors the electrical and mechanical ideals clash, since a nearly isochronous governor is fatal for the parallel running of alternators. It is only by an electromagnetic combination, controlling both the steam (or turbine water) admission and the excitation, that the speed (and also voltage) can be automatically and satisfactorily maintained constant. The author's devices to attain this object are described, and he emphasises their simplicity of construction.

(1) For direct currents a differentially wound solenoid is employed. As the load comes on, a series winding reduces the effect of a shunt winding, allowing a weight-controlled core to move, which motion admits more steam,

Digitized by Google

reduces the machine field resistance, and also reduces a resistance in the shunt circuit of the solenoid itself, thus counterbalancing the effect of the series turns. The contacts of the regulating resistances for the machine and solenoid shunts, together with the motion imparted to the steam control, are so adjusted that, for any alteration in load, the increase of the solenoid shunt just counterbalances the series turns after the core has moved enough to admit sufficient steam and extra excitation for the new load. Whatever the load, the speed and volts thus remain constant and, if desired, the volts may even be over-compounded. The device is said to consume about 100 watts. (2) For alternating currents the author substitutes an induction motor for the solenoid.

The author proceeds to develop a diagram analogous to Hartnell's governor diagram. He assumes that with a long core projecting beyond the ends of the solenoid, the sucking force is proportional to the ampere turns and independent of the position of the core. The utility of the ordinary Hartnell diagram is badly modified by the inertia of the moving parts of a centrifugal governor. The governing of turbines is touched upon, and devices, including an hydraulic relay, described. The mechanical details of the adjustable shunt resistances used by the author are illustrated, and the inherent voltage regulation of alternators having high and low armature-reaction is explained. R. C. R.

886. *Unipolar Coreless Dynamo.* **O. Grotrian.** (Ann. d. Physik, 10. 2. pp. 270–286, Jan. 27, 1903.)—Two types of actually constructed machines are described by the author, one being a motor, and the other a generator (separately excited), and the experimental results obtained are compared with those deduced from purely theoretical considerations. The generator consisted of a solenoid wound on ebonite bobbins mounted on an insulated brass spindle which could be driven at any desired speed; in addition to two contact-rings for supplying current to the solenoid, two other contact-rings were provided, both in metallic connection with the spindle, one being mounted at the middle of the solenoid and the other just outside one end of it. These two contact-rings could be connected to a suitable milli-voltmeter; in some of the experiments contact was made directly with the end of the spindle instead of with the external contact-ring. The author shows that the ordinary theory, according to which the e.m.f. induced is calculated from the speed and the total flux proceeding from one end of the solenoid, gives entirely erroneous results; and that correct results are obtained by taking for the useful number of lines cut the difference of the magnetic fluxes passing through the two contact-rings. A. H.

887. *Undulatory Currents.* **R. Salvadori.** (Atti Dell' Assoc. Elettr. Ital. 7. pp. 26–33, Feb., 1903.)—Since the e.m.f. generated by any continuous-current dynamo may be expressed as the sum of a number of sinusoidal elements, it must be to some extent undulatory. But even with only 20 segments per pole, the variation will be only 0·3 per cent. Such a machine may, however, give a *current* much more distinctly undulatory, as, for instance, when working against a constant back e.m.f. like a battery of accumulators. The same may happen in the case of a motor driven from a source of constant e.m.f. The frequency of these undulations is so high that a small self-induction in the circuit will stifle them, but in a magnetic circuit already fairly saturated, considerable variations of current may occur with small variations of B. The readings of ammeters and voltmeters in such circuits are

Digitized by Google

discussed. Permanent magnet instruments will give the true mean current, but other types will give a different reading, which may involve considerable error, while their product may differ considerably from the true power. It is suggested that these effects may be of importance in measurements of accumulator charge and discharge, of efficiencies of motors, dynamos, and convertors and in electrolytic work. The author explains on this hypothesis the effects described by Banti in experiments with a converter and a battery, and attributed by him to electrolytic pseudo-capacity. [See Abstract No. 492 (1903).] A. E L.

888. *Parallel Running of Alternators.* **G. Benischke.** (Elektrotechn. Zeitschr. 24. pp. 195–198, March 12, 1903.)—A reply to the arguments of Görges. The following articles are referred to : Elektrotechn. Zeitschr, 1902, pp. 425, 948, and 1053 [see Abstracts Nos. 1508, 1360 (1900), and 689 (1903)]. The author concludes that the problem of calculating theoretically whether or not alternators will run well in parallel is too complex for solution. It is only possible to say that when the values of the flywheel effect, &c., are such that the periods of the natural and impressed pendulum action are widely different, there is no danger of bad parallel running; but even if these periods become nearly the same, it is not safe to say that the machines must run badly in parallel. R. C. R.

889. *Testing of Alternators.* **F. Loppé.** (Écl. Électr. 34. pp. 266–272, Feb. 21, 1903.)—The methods proposed and discussed by Behn-Eschenburg, Rothert, Blondel, Potier, and Picou [see Abstracts Nos. 975 (1902) and No. 684 (1903)] for pre-determining the regulation of an alternator working on a load of given power-factor from its open-circuit and short-circuit characteristics, are briefly referred to by the author, who then describes a method involving, in addition to these characteristics, a knowledge of the p.d. corresponding to one particular value of the armature current at a given excitation. Two cases are considered by the author : (1) When the armature current is practically wattless; (2) when it has an appreciable load component. In either case, the single reading obtained is, along with the open and short-circuit curves, sufficient for determining the constants required for the construction of the complete load characteristic for any given power-factor. The author tests the method by applying it to experimental data, and finds very good agreement between theory and experiment. A. H.

890. *Double-Current Generating Sets.* **F. Collischonn.** (Elektrotechn. Zeitschr. 24. pp. 231–234, March 26, 1903.)—The article relates, not to the so-called double-current generators with one armature, but to the arrangement of two dynamos direct connected to a single engine, each dynamo generally having a rated capacity corresponding to that of the engine. The Elektricitäts A.-G. vormals W. Lahmeyer and Co. have made a speciality of such sets, and installations may be found at Gotha, Homburg, Wiesbaden, Charlottenburg, Aachen, and elsewhere. Sometimes both machines are for continuous current, one for lighting at—say—220 volts, the other for tramways at 550 volts. In other cases, one generator is for high-tension polyphase current, the other for continuous current. This practice provides ample spare generators at a lower initial outlay than would be required were each generator driven by an independent steam engine. Floor space is also economised. Generally, only one or the other generator is in circuit, but it is pointed out that by intelligent management one may obtain high

Digitized by Google

economy by running with both generators in circuit, their combined load being maintained at the steam engine's most economical load. One, or the other, and sometimes both generators are of the flywheel type, and the very complete and illustrated descriptions of some continuous-current flywheel generators is a feature of the article. Arnold windings—otherwise known as two-circuit, multiple windings—are employed, and this adds to the importance of the data given.

The two generators employed at the Aachen Central Station constitute a combined flywheel aggregate. Each has a normal capacity of 700 kw. for permanent operation; 830 kw. for three hours; and 1,000 kw. for half an hour. The one is for 600/660 volts for the tramways, and the other delivers 250/290 volts for lighting. Further data relating to these two machines is given in the following:—

Voltage	250/290 ...	600/660
Kilowatts rated output	700	700
Speed (r.p.m)	110	110
Armature diameter	3,700	3,700
Armature length	244	244
Number of poles	20	16
Number of slots	840	764
Conductors per slot	2	2
Number of conducting paths through armature from positive to negative brushes	20	8
Armature copper (mm.)	3 × 15	3·5 × 15
Slot dimensions (mm.)	5·2 × 38 ...	6·2 × 38
Number of commutator segments	840	764
Diameter of field bore (mm.)	3,718	3,720
Diameter of magnet wire (mm.)	6·0, 6·5	4·2, 4·7
Number of turns per pole	390	1,100
Weight of copper (kg.)		
Armature	670	830
Field	2,400	3,100
Weight of total rotating part consisting of two armatures with commutators, spider, and shaft	40,000 kg.	
Weight of total stationary parts (2 magnet frames)	59,000 kg.	

RESULTS OF OFFICIAL TESTS.

	Load.				Temperature Increase (guaranteed 40° Cent. max.).		
	Volts.	Amps.	Kw.	Duration in Hours.	Arm.	Comm.	Field.
250/290-Volt Machine...	246	3,315	815	3	20	35	10
„ „ „	246	2,896	712	10	22·5	27·5	10·5
600/660-Volt Machine...	607	1,211	736	9⅓	21	15	9

The efficiency of the 250/290-volt machine at 712 kw. was 87·2 per cent.
„ „ „ 600/660 „ „ „ 736 kw. „ 88 „
as against the guaranteed efficiencies of 82 per cent. and 82·3 per cent. respectively. H. M. H.

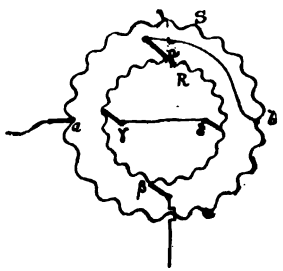
Digitized by Google

891. *Regulating Rheostats for Separately Excited Machines.* **C. Kinzbrunner.** (Elektrotechn. Zeitschr. 24. pp. 234–235, March 26, 1903.)—In the testing departments of dynamo factories and in laboratories, it is often necessary to be able to adjust the excitation of the field windings at any one of a wide range of values, as, for instance, in the case of testing booster sets. This can seldom be satisfactorily done with rheostats of any reasonable cost, connected in series with the windings. But by tapping off to the winding from a suitably proportioned rheostat connected across the mains, a so-called "shunt" rheostat, very satisfactory control of the excitation can be obtained. Such a rheostat is more satisfactory for testing purposes, the higher the ratio of resistance of spool windings to resistance of shunt rheostat. But this is the least economical arrangement. The article contains diagrams and curves facilitating the calculation of such rheostats for various cases. H. M. H.

892. *Speed Control of Electric Motors on Constant Pressure Mains.* **W. B. Sayers.** (Inst. Engin. and Shipbuilders, Trans. 46. 6. pp. 43–58; Discussion, pp. 58–64, March, and 46. 8. pp. 4–14, April, 1903.)—The output limit of a motor when speed is varied by varying excitation is a constant quantity, since the maximum armature current must remain practically constant, and the torque vary as the product of current into magnetic field. For a variable speed motor, the size in h.p. = size in h.p. of standard speed motor to do the maximum work $\times \frac{\text{maximum speed}}{\text{minimum speed}}$, and the efficiency $= 100 - x \times$ percentage losses of motor at standard speed and output $\times \frac{\text{standard output}}{\text{variable speed output}}$. The author gives a table of sizes of motor required, in terms of rated h.p. at normal speed, for speeds variable through ranges of 15 per cent., 33 per cent, 2 to 1 and 3 to 1. He discusses the effect of variable speed on the efficiency, giving figures for the various losses at different speeds. *Discussion.*—**H. A. Mavor** said the prime point in the matter was the commutator difficulty, and the whole thing depended on the reactance voltage. The reactance voltage per section = watts input × turns per section × magnetic field produced by winding per Cr length of wire ÷ diameter of armature × average density of flux in air space, taken over the whole surface of the armature. **Henry Lea** gave figures relating to cost and efficiency of some 5, 6, and 7½ h.p. motors driving fans at 600 to 900 revs. **W. A. Chamen** mentioned a system devised by A. H. Pott. The proposal was to have, say, 300 volts between one outer and the middle wire of a three-wire system, and 200 volts between the middle and the other outer, giving three different voltages. A further variation might be obtained by using a double-ended armature, the two windings to be used either in series or in parallel. **W. L. Spence** described a 460-volt, 5-wire system giving the following pressures: 95, 135, 190, 230, 325, and 460. **M. M'Lean** thought the method of putting resistance in the armature should not be summarily dismissed, for variations of speed not exceeding 20 to 30 per cent. The percentage reduction of speed would not be very different from the percentage reduction of efficiency. **T. B. Murray** said the difficulty with brushes could be got over, to a certain extent, by using multiple brushes. He mentioned a double-wound armature with two commutators, introduced first by Messrs. Egger, of Vienna. This was very useful for motor car work. He found it advisable not to rely on carbon brushes for reversing, but he had used a system of reversing magnets energised by the main current. The **Author,** in reply, pointed out that if series resistance was used, the capacity of the motor to maintain constant speed with variable load was ruined. R. B. R.

Digitized by Google

893. *Single-phase Motor with Phase Compensation.* **M. Latour.** (Écl. Électr. 34. pp. 225–228, Feb. 14, 1903.)—The author points out that the ordinary type of laminated-field series-wound commutator motor has a very serious drawback which it is impossible to get rid of—the vicious sparking which results from the e.m.f., induced in the short-circuited coil by the alternating field. He describes a new type of series-wound commutator motor, recently invented by himself. This motor runs sparklessly at all loads, has a power-factor of unity, and is capable of exerting an extremely powerful starting torque. Its general construction will be understood by reference to the cut, in which S denotes the stator and R the rotor winding. The stator is precisely similar to that of an ordinary induction motor, the winding being embedded in slots in the laminated core. The rotor winding is, on the other hand, similar to that of an ordinary continuous-current armature, and is provided with a commutator. The diagram refers to a two-pole machine. Current is supplied at *a*, and flows both ways round the



stator winding to *b*, giving rise to a horizontal alternating field along *a b*. From *b* it passes to the brush *a*, thence both ways round the rotor winding to brush β, and, finally, to the main. So far the motor resembles an ordinary series-wound motor. Its special feature consists in two additional brushes, γ and δ, arranged at right angles to the first pair, and *short-circuited* by a conductor of low resistance. The effect of this short-circuited pair of brushes is practically to wipe out the horizontal field produced by the stator winding, and to destroy the induced e.m.f. which gives rise to sparking at the brushes α and β. Further, when the motor is running at nearly synchronous speed, the e.m.f. induced in the short-circuited coils at γ and δ by the alternating flux along $\alpha\beta$ has the proper direction, and is of nearly the right amount for sparkless commutation at these brushes. The current flowing between γ and δ is, at a speed approaching that of synchronism, made up of (1) the current which wipes out the field along *a b* produced by the stator winding, and which thereby annuls the self-inductance of that winding; (2) the current due to the rotation of the rotor in the vertical field produced by the current flowing between α and β. This current is in quadrature with the main current, and hence the field which it produces along $\gamma\delta$ when compounded with the vertical alternating-field gives rise to a rotating field whose speed nearly coincides with that of the rotor. The self-inductance of the latter will nearly disappear, and the p.d. across $\alpha\beta$ will be nearly equal to the resistance drop simply. The author states that motors of this type are in process of construction by Postel-Vinay, and promises to publish tests of their performance at an early date. A. H.

894. *Testing of Induction Motors.* **P. Meunier.** (Écl. Électr. 34. pp. 228–231, Feb. 14, 1903.)—The method proposed by the author is similar

Digitized by Google

to Potier's modification of the Hopkinson test for continuous-current machines. The two motors to be tested are belted together, but are fitted with pulleys of different diameters, so that when one of them runs as a motor *below* the speed of synchronism, it drives the other, which acts as a generator, *above* the speed of synchronism. By measuring the power supplied from the mains, and that given to the motor by the generator, the efficiency may be easily found in the usual way, if allowance is made for the loss in the belt. The author considers the theory of the method in detail and discusses its practical advantages and disadvantages. A. H.

895. *Theory of Single-phase Induction Motor.* **H. Görges.** (Elektrotechn. Zeitschr. 24. pp. 271–274, April 9, 1903.)—After criticising some of the existing theories of the single-phase induction motor, the author develops a theory of his own, the essential feature of which consists in regarding the e.m.f. induced in the rotor windings as consisting of two components: (1) A component due to the periodic variation of the magnetic flux through the rotor (this is the *only* component when the rotor is at rest); and (2) a component due to the rotation of the conductors in the field. Component (1) is only capable of producing ampere-turns whose magnetic axis coincides with that of the stator field; while (2) can only produce a cross-field. This leads to the substitution, for the actual rotor windings, of two mutually perpendicular coils (the field being assumed a two-pole one) fixed in space, and to the construction of a suitable diagram by means of which a number of useful formulæ are established. A. H.

REFERENCES.

896. *Manufacture of Large Dynamos and Alternators.* **E. K. Scott.** (Inst. Elect. Engin., Journ. 32. pp. 362–427; Discussion, pp. 429–469, March, 1903.)—A description of various modern designs, with notes on methods of manufacture. The paper, which is accompanied by numerous diagrams and tables, contains too much detail to be suitable for abstraction. A. E. L.

897. *Excitation of Asynchronous Generators by Means of Condensers.* **A. S. McAllister.** (Elect. World and Engineer, 41. pp. 109–110, Jan. 17, 1903.)—The author has conducted a series of experiments showing that an asynchronous generator may be rendered self-exciting, and operate much in the same manner as a shunt-wound direct-current machine, if condensers of suitable capacity are connected across the stator terminals. W. G. R.

898. *Compensated and Compounded Asynchronous Machines.* **A. Heyland.** (Elektrotechn. Zeitschr. 24. pp. 213–214, March 19, 1903.)—This paper describes some further modifications of the arrangement of commutator connections and resistances which was published in the last paper [see Abstract No. 781 (1903)]. Only a few of the commutator segments are now connected by resistances, and the resistance losses are greatly decreased. J. B. H.

899. *Self-inductance.* **F. Emde.** (Zeitschr. Elektrotechn., Wien, 21. p. 89, Feb. 15, 1903.)—A brief article in reply to some criticisms by Eichberg [see Abstract No. 494 (1903)]. A. H.

900. *American Practice in Electric Motor Construction.* (Amer. Electn. 15. pp. 20–40, Jan., 1903.)—This is a photographically illustrated summary of American electric motors of recent design. G. W. DE T.

Digitized by Google

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

901. *Electric Transmission Lines.* **A. D. Adams.** (Cassier, 23. pp. 650–655, March, 1903.)—The consideration of the cost and physical properties of the various metals and alloys which have been employed for electric power transmission, leads to the conclusion that the choice should be confined to copper and aluminium. For equal conductivity, an aluminium wire has a greater tensile strength than one of medium hard copper, and costs less than copper of any grade, when the price per pound of the aluminium is less than twice that of copper, which is usually the case. A table is given which illustrates the practice in some of the more recent and important transmissions, all of which carry either two-phase or three-phase current. The distance between the wires is 18 in. on the Niagara line; 24 in. on the Madrid and the Hamilton lines; 50 in. on the Cripple Creek line; only 36 in. on the Colgate line, in spite of the high voltage; and 78 in. on the Cañon Ferry line. [See also Abstract No. 551 (1903).] G. W. DE T.

902. *Transformers in Transmission Systems.* **A. D. Adams.** (Elect. Rev. N.Y. 42. pp. 496–498, April 11, and pp. 535–536, April 18, 1903.)—The writer describes static transformer practice in America. For transmission over less than 15 miles it is generally better to avoid the use of transformers at generating stations. Generators up to 13,500 volts are now regularly manufactured. Generators giving from 10,000 to 13,500 volts are employed at Manchester, N.H., Lewiston, Me., and Salem, N.C. But for distances exceeding 25 miles step-up transformers are employed. 50,000 to 60,000 volt transmission lines represent present highest practice—Colgate to Oakland and San Francisco, 40,000 volts; Cañon Ferry, on the Missouri River, to Butte, 50,000 volts. The writer then discusses the relative groupings employed for generators and transformers and their relative capacities, and gives practical cases where these various combinations have been installed. Three-phase transformers are practically not yet used in the United States, the arrangement almost invariably consisting of groups of three single-phase transformers. The writer notes the strong tendency towards decreased frequencies, and comments on some of the advantages. Transformers of 100-kw. capacity and upwards (in present practice single transformers of over 1,000-kw. capacity are frequently met with) employ artificial cooling by water-pipes in oil and by cooling dry transformers by means of an air-blast. In a substation at Manchester, N.H., twenty-seven 200-kw. transformers which are cooled by air-blast require less than 1 h.p. of motor capacity for each 200-kw. capacity in transformers. Where a motor-driven blower is employed per group of transformers, it is a common practice to lead the air directly from each blower to the group of transformers by a metal duct, thus avoiding the necessity for an air chamber. In such cases, a blower giving a three-eighth-ounce air pressure per sq. in., and a motor of 1-h.p. capacity, are generally installed for each group of three transformers of some 125-kw. capacity each. As to water-cooling, one manufacturer estimates that the amount required (supplied at 15° C.) to be forced through

Digitized by Google

the transformers to prevent a rise of more than 35° above air when operating under full load, would be—

Kilowatts Total Capacity of Transformers.	Gallons of Water Required per Minute.
75	0·37
150	0·50
400	0·75
600	1·00
1,000	1·5

The writer cautions against maintaining artificially-cooled transformers at a temperature lower than that of the surrounding air, lest harm result from condensation upon its parts. In connection with possible subdivision of secondaries into distinct coils for feeding independent systems, a plant is mentioned at Manchester, N.H., where a novel and interesting arrangement is employed. Each of a group of three single-phase transformers fed from a three-phase circuit, has two independent secondaries. Three of these secondaries, one on each transformer, are connected together and supply a 380-volt three-phase rotary converter. The other three secondary windings are connected in like manner to a second rotary converter. Each of these transformers is rated at 250 kw., and each rotary is rated at 300 kw., so that the transformer capacity amounts to 750 kw. and that of the converters to 600 kw. Amongst the rather large number of plants by which the writer illustrates his statements and conclusions, three in particular are frequently referred to, and the data of these three plants, so far as could be gathered from the article, may be summarised as follows: *Data of Transmission Plants.*—Apple River to St. Paul: At generating station, which contains four 750-kw. three-phase 800-volt generators, there are six 500-kw. transformers connected in two sets of three each, and at the substations six 300-kw. and four 200-kw. transformers, the transmission being effected at 25,000 volts. Colgate to Oakland (and San Francisco): Three 1,125-kw. and four 2,250-kw. three-phase 2,300-volt, 60-cycle generators and step-up transformers in 700-kw. units, arranged in Y connected groups, are employed. Each transformer has three sets of taps brought out from its secondary coils, permitting of obtaining line voltages of 40,000, 50,000, or 60,000 volts; the higher voltages will, it would seem, be employed later as the load increases. Cañon Ferry to Butte: The electrical generating plant consists of ten 750-kw. 550-volt 60 ∿ three-phase generators. By means of six 950-kw. Δ-connected transformers, the power is stepped up to 50,000 volts and transmitted to a substation at Butte. Two transmission circuits are provided for this purpose. The six 950-kw. transformers in the Butte substation are arranged in two groups. The generating station also contains twelve 825-kw. transformers arranged in four groups of three each, and supplying substations at Helena. The total capacity of step-up transformers is—apparently, the writer states, in the interests of regulation—9,600 kw., as against a capacity of only 7,500 kw. in generators. H. M. H.

903. *Arrangement of Transformers in Alternating-current Installations.* **G. W. Mayer.** (Elekt. Runds. 20. pp. 134–135, April 1, and pp. 143–145, April 15, 1903.)—The writer urges the importance of subdividing the transformers into as few units as possible, and of specifying transformers of high "all day" efficiency, not only as to initial performance, but after a long period of service. He shows by examples that it is economical to pay considerably

Digitized by Google

more for such transformers than for others of lower efficiency, the increased cost of operation in the latter case amounting in the course of but a few weeks to the difference in initial cost. The writer maintains that the saving in the transformers, in connections, &c., by using a few large transformers instead of many small ones, more than compensates for the resulting increased cost of the secondary network, which latter should, however, be maintained low by employing the three-wire system. Furthermore, small transformers require to approach in capacity much more nearly to the total capacity of the apparatus connected in circuit than is the case in large transformers, for in the latter case a closer approach to average values can be used with safety in selecting the capacities of the transformers. In an actual case which he describes the no-load losses were reduced from 88,900-kw. hours per year to only 2,700-kw. hours per year, *i.e.*, to only 7 per cent. of their former value, by the substitution of two large transformers for a large number of small transformers. There was also the further saving in reduced line losses. This is followed by the description of another case, where, on substituting five large for seventy-one small transformers, the yearly expenditure of energy for supplying the core loss alone was reduced by 95 per cent. The writer discusses the increase in core loss due to ageing. It follows from the cost of supplying this increased energy that it is desirable to maintain the transformers at a low temperature during service, since ageing of iron is due to long-continued high temperature. Oil transformers are recommended, not only on account of the cooling effect of the circulating oil, but on account of its preservative effect on suitably chosen insulation materials. The writer prefers transformers of the mantle type to the core type, chiefly on account of the less difficulty in the former construction of economically avoiding high potential differences between adjacent turns of successive layers. He admits that that construction is less simple. He gives interesting data of such transformers.

H. M. H.

904. *German Rules for Electrical Plants.* (Elektrotechn. Zeitschr. 24. pp. 141–156, Feb. 19, 1903. Paper read before the Verband Deutscher Elektrotechniker).—In the new edition of the official rules the "medium tension" is abolished. Low-tension plants are defined as those having not more than 500 volts between wires or 250 to earth. The insulation resistance is required to be 1,000 ohms multiplied by the voltage for each section between two fuses or beyond the last fuse. This rule does not apply to wiring in damp places, for which special precautions are prescribed, but no minimum insulation resistance. A scale of current densities is given as in previous editions—ranging from 5·33 amperes per sq. mm. for a section of 0·75 sq. mm., to 1 ampere per sq. mm. for a section of 1,000 sq. mm. The smallest section allowed is 1 sq. mm., or in fittings 0·75 sq. mm. Special rules are given for places containing explosive gases, for shop windows, theatres, and mines, fiery and otherwise. High-tension plants are defined as those in which the voltage to earth may exceed 250 volts. Traction plants are excluded from the regulations. A scale is given for the minimum insulation resistance between two fuses ranging from 1,000 ohms multiplied by the voltage for 250-volt plants to 500 ohms multiplied by the voltage for plants working at 1,000 volts or over. The test is to be made, if possible, with the working tension, or failing this, with at least 100 volts. The insulation of wires is required to stand a test tension, after 24 hours' immersion, of double the working tension when this is 500 volts or under, 500 volts excess tension for working tensions from 500 to 1,000 volts, and

Digitized by Google

above that 50 per cent. excess tension. High tensions are not allowed in wet places, theatres, or shop windows. Tensions above 1,000 volts are not allowed in places exposed to acid fumes, and in damp places only if run in cables. The regulations for the working of electrical plants relate chiefly to precautions for the safety of workmen, such as posting notices of dangerous points. No eating, drinking, or smoking is allowed in accumulator rooms, and men are to be specially cautioned as to the dangers of acids and of lead poisoning. For the working of high-tension plants rules are given as to the switching out of circuits before work is done on them and the special precautions necessary where this is impossible. A. E. L.

905. *Voltage Regulation of the Vienna Five-Wire Municipal Lighting Plant.* **R. Hiecke.** (Zeitschr. Elektrotechn., Wien, 21. pp. 229–236; Discussion, p. 286, April 19, 1903. Report read before the Elektrotechn. Verein at Vienna, Feb. 25, 1903.)—The article contains a very detailed description of the switchboard apparatus, so far as relates to the voltage control, and of the equalising appliances which comprise accumulators and balancers. The writer subdivides the question into the control respectively of, first, bus-bar voltage; second, voltage of the distribution network; third, voltage at the lamps. The Vienna lighting plant, to which his description relates (which up to recently also supplied power to the tramways) comprises two power-houses and numerous substations. These supply a five-wire distribution network. From each feeding-point, independent testing wires are led back to the central station, from which the voltage control is effected in accordance with observations made by means of a number of special instruments which the writer describes at length. The voltage between the outer wires is brought to the required value, preferably by adjustment of the speed of the steam engine, since the large (600 to 1,500 h.p.) dynamos respond but slowly to altered excitation. By the accumulator switches the load is divided in the desired proportion between dynamos and accumulators. Although the centre of control and the main accumulator installation are 2 km. distant from the dynamo plant, perfectly satisfactory control is nevertheless effected by means of direct signal and telephone connections. The accumulator sub-stations are, on the other hand, controlled quite independently of the main station, each drawing from the latter the current corresponding to its varying requirements. In the main station, dynamos of 500 volts and 250 volts are installed; the 125-volt component groups being maintained at the required potential by subdivision of the accumulator, by equalising machines and by subsidiary accumulators called buffer-batteries, which are installed at the distant ends of the line, and are capable of withstanding heavy but intermittent charges and discharges, and do not require the presence of attendants. These buffer-batteries have no switch-gear for adjusting the number of cells in circuit. They require the presence of an attendant for but one-half hour per day, and have to be specially charged once a week for a few hours. The equalisers consist in each case of four windings leading to four commutators, the four windings being on a single armature core revolving in a single shunt-excited field. This is stated to have the advantage that the equalising occurs purely in virtue of the difference in the voltage drop in the four respective sections of the five-wire system, and that armature reaction plays no part. In fact, the resultant armature reaction of the four windings approximates closely to zero. The field excitation is supplied from the two outer wires. The equalising machine operates as motor from the less loaded of the four sections, acting as generator to aid the more heavily

Digitized by Google

loaded sections. Partly in virtue of the considerable flywheel effect of its armature, the equalising machine, in addition to its chief function, also exerts a very appreciable influence in contributing to the constancy of potential between the two outer wires; this is, however, also in part, due to its property of distributing amongst the component sections, according to their respective and constantly varying requirements, any tendency to voltage variation between the outer conductors. The writer concludes by describing various provisions against, and in case of, interruptions in the service. H. M. H.

906. *Central Power Stations in Europe.* **L. Gerard.** (Soc. Belge. Élect., Bull. 20. pp. 177–188, April, 1903.)—The author, after referring to the mistaken idea that large water-power stations are only to be found in America, gives some details concerning the Vizzola generating station: one of the most important generating stations of this type in operation in Europe. He then passes on to consider the prospects of central power stations relying upon coal and steam power. As regards the Vizzola Power Station [see Abstract No. 460 (1901)], the author states that 22,000 h.p. has been developed with a capital expenditure of 40,000,000 francs. The comparison of costs for electrical power generated from water and coal respectively, is based chiefly upon figures which have been published by Saint Martin in a recent book upon "Les Distribution d'Energie Electrique." This author states that the capital expenditure per kw. of plant installed in steam-driven stations, varies from 600 to 1,600 francs, according to the size and scale of the station. The corresponding figures for water-power stations are given as 2,200 and 2,700 francs. As an example of the costs of water-power development in France, Saint Martin cites the figures for the station of the Société de Jouage à Lyon, where 20,000 kw. have been developed at a cost of 40,000,000 francs. As regards tariffs, Saint Martin has given the following figures for water-power in Switzerland:—

For motors using $\frac{1}{10}$ to 1 h.p.....300–250 francs per h.p. per annum.
„ „ 30 to 50 h.p.....200–150 „ „ „
„ „ 50 to 100 h.p.....150–120 „ „ „

In the district of St. Etienne, in France, electric power is sold at a price ranging from 800 to 600 francs per h.p. per annum; while the Société Jouage à Lyon has a tariff which ranges from 120 francs to 360 francs. Saint Martin believes, in the light of these figures, that a central station, driven by steam, could produce electric power as cheaply as (and therefore compete with) these large central water-power stations. Taking the capital expenditure and present receipts of two typical generating stations of this type, we have the following comparison:—

Water Power..... Capital Expenditure 50,000,000 frs., Receipts 2,277,762 frs.
Steam Power..... „ „ 12,000,000 frs. „ 1,300,000 frs.

The first of these stations has a tariff higher than that of a number of small steam-driven generating stations in the same district, and has a difficulty in even meeting its standing charges. The second operates on an absolutely economic basis, and returns a dividend on its capital. The author concludes by stating his belief that central power stations driven by steam, if well planned and wisely situated as regards supplies of coal and distribution of current, can compete on favourable terms with water-power stations; and expresses his confidence in the future of coal for the generation of electrical energy in the coal-bearing districts of Europe. J. B. C. K.

Digitized by Google

907. *Power-Station Arrangement for Electrically Operating Steam Railways.* **C. J. Spencer.** (Elect. World and Engineer, 41. pp. 272–273, Feb. 14, 1903.)—The author discusses the relative merits of centralising the power plant, distribution by high-tension alternating current to substations, and the continuous-current system with several generating stations spaced at certain distances along the line. He advocates continuous-current stations, with accumulators, generating at 600 volts, spaced along the roads ten miles apart, with accumulator houses between every two generating stations. With the distributed system of stations there is greater immunity from breakdown, and no more reserve machinery would be necessary than in the central station system. F. B.

908. *Measurement of Insulation Faults in Multiple-Wire Systems.* **E. Müllendorff.** (Elektrotechn. Zeitschr. 23. pp. 1080–1081, Dec. 11, 1902.)—The author points out that insulation tests of multiple-wire systems, made by the usual methods, suffer from two drawbacks. They afford neither information as to the distribution of the faults on the separate conductors, nor take account of the faults resulting from a cross from one conductor to the other (so long as the current does not go to earth). He then describes a method, applicable to any number of wires, which is free from these disadvantages, and with which the measurements can be made with the working voltage. An example of the method is worked out in the paper for the simple case of a three-wire system. L. H. W.

909. *Street Lighting in New York and the Proposed Municipal Plant.* (Eng. News, 49. pp. 250–258, March 19, 1903.)—This subject has been forced suddenly to the front in New York by the action of the Board of Estimate and Apportionment, under the Presidency of the Mayor, W. Seth Low, in March of this year. Reports upon the lighting of New York have been submitted to this Board by R. S. Monroe and C. F. Lacombe respectively, which are reprinted in full in the present article. Monroe's Report deals with the bids for the public lighting made by the various city electric light and power companies, and gives details of the capitalisation of these companies, and of the inflation in stocks that has occurred in recent years. Lacombe's Report compares the cost of public lighting in New York with that of other cities in the United States of America—both gas and electricity being included in the comparison. In the case of gas-lighting the extremes of cost are as follows: Per lamp per year—Open-flame burners, \$18·04 (Manhattan, New York), \$25 (Queen's, New York); Welsbach burners, \$18·55 (Chicago), \$31 (Binghampton). For electricity, both private company and municipal plants are compared, the latter in most cases showing the lowest costs. The extremes are \$48 per lamp per year in Jamestown, N.Y. (municipal plant), and \$146 in New York City (private company plant). An estimate prepared by Lacombe for the cost of lighting by a municipal plant in New York City shows a saving of \$690,574 per year upon the present expenditure. The following are the conclusions of Lacombe's Report: (1) New York should receive much lower prices than it does. (2) That it would be very profitable for it to operate its own electric plant, one capable of furnishing all its arc lights and all incandescent lights necessary for public lighting. (3) To reduce its number of gas lamps by increasing electric arcs at the lower prices obtained; change all its open-flame lamps to mantle burners and maintain them itself or through contracts with private parties for repairs, &c. (4) It would also seem advisable that its present bids for lighting for the year be rejected, and new bids

Digitized by Google

taken under revised contracts, which will give it at least a chance to save in mantle gas lights, this having been demonstrated as possible under existing circumstances. In electric lighting it should be given more authority to enforce penalties for outrages or other neglect. J. B. C. K.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

910. *Hydro-Electric Power Plant in Newfoundland.* **E. E. Boardway.** (Elect. World and Engineer, 41. pp. 391–392, March 7, 1903.)—A small stream at Petty Harbour is used to generate power to run the electric trams at St. John's, 9 miles distant. The waterways are described, the flume being about 1 mile long, built up of 12 in. × 12 in. timbers lined with 3 in. planks, and the inside dimensions are 13½ ft. × 13 ft. The head is about 185 ft. A horizontal turbine of the Francis reaction type, with an upward discharge, develops 1,860 h.p. at 325 r.p.m. and is coupled direct to two alternators, one at each end of the shaft, each of 600-kw. capacity at 500 V., 60 ∿. Step-up transformers raise the pressure to 15,000 volts. Owing to the pitting of the backs of the buckets and the nozzles in this type of turbine, the second turbine installed was of the Girard inward-flow type. Both are equipped with momentum flywheels 7 ft. in diameter, weighing 15,500 lbs., and running at a peripheral speed of 7,200 ft. per min. The controlling gate is a large hydraulic gate valve actuated by a Lombard water-wheel governor. Illustrations of the pole line, flume, dam, and power-house—interior and exterior views—are given. F. B.

911. *Electricity Supply in Athens and the Piræus.* (Électricien, 25. pp. 225–231, April 11, and pp. 241–244, April 18, 1903.)—The original installation for the lighting of Athens was situated in the centre of the city, where water supply and facilities for extension were lacking. A new generating station has therefore been erected near the sea-coast, to supply Athens and the Piræus, and the railway between these places. There will ultimately be six generators of 750 kw. each, generating three-phase currents and direct current. Steam is supplied by eight multitubular boilers, each having a heating surface of 256 sq. m., provided with superheaters which raise the temperature of the steam to 300° C. The normal working pressure is 180 lbs. per sq. in. The feed-water is heated by economisers to 100° C. Surface condensers are used, with circulating water from the sea, whence it is raised by motor-driven centrifugal pumps. There are two three-phase generators at present, each having an output of 750 kw. at 5,500 volts; these are driven direct by triple-expansion, four-cylinder, horizontal engines at 94 r.p.m. The cyclical variation in one revolution is 1 in 275. There are two small sets, each consisting of a steam engine of 110 h.p., driving a dynamo of 75-kw. output at 125 volts, 250 r.p.m., and a three-phase alternator of the same output at 5,500 volts; these alternators are used for supplying the Piræus. There are also two direct-current generators of 750 kw. each, at 600 volts, for traction. Power is transmitted to Athens by two aerial lines, each 6,300 m. in length. Each line consists of three conductors of 50·2 sq. mm. section, 50 cm. apart, carried on triple-shed insulators by wooden poles. The lines end in a substation on the outskirts of the city, whence the power is conveyed by underground cables of 3 × 70·2 sq. mm. section, insulated with impregnated jute, lead-covered and armoured, to substations in the city. Two other aerial lines, 2,700 and 1,000 m. long, feed substations at the Piræus

Digitized by Google

and Phalère. In the Athens central substation the pressure is lowered by air-cooled transformers to 170 volts, at which pressure the current is led into rotary converters giving direct current at 250 volts. A battery of 8,400 ampere-hours is provided for the lighting service. Other converters are to be installed for supplying the tramways. In a second substation motor generators are used, without transformers. At the Piræus motors are used to drive shafting, from which six direct-current generators of 50 kw. each and two arc-light dynamos of similar output are driven. At Phalère transformers and rotary converters are installed. The article is illustrated with photographs and drawings. A. H. A.

912. *Tunbridge Wells Electric Light Station.* (Elect. Rev. 52. pp. 577–580, April 3, 1903.)—The latest extensions are here described. Owing to the hardness of the water, the additions to the boiler-house consist of Lancashire boilers, two of which, 30 ft. by 8 ft. 6 in., are now in use. The main steam pipe is 12 in. in diameter. A new chimney is being built, 180 ft. high, with an internal diameter of 8 ft. 3 in. Surface condensers are used in connection with a cooling tower, 76 ft. high. Two new steam alternators have been put in; the first, made throughout by Ferranti, gives 500 kw. at 202 r.p.m.; the other, by Willans-Parker, gives 450 kw. at 292 r.p.m. The street lighting comprises 82 arc lamps, replaced by incandescent lamps at midnight. The charge is the same as for the gas lighting, which it supplanted, and is at the rate of 1·25d. per unit—below cost price, it is said. W. H. S.

913. *Vancouver Transmission Plant.* **W. H. Allen.** (Elect. World and Engineer, 41. pp. 645–648, April 18, 1903.)—This paper gives details of the construction of the water-power electric transmission plant of the Vancouver Power Company, Limited, which is now in course of construction, and which is intended to supply light and power for the operation of the street and interurban railways in Vancouver, New Westminster, and Burnaby. The initial installation of machinery will have a capacity of 6,000 h.p., but the ultimate capacity will be 24,000 h.p. The water supply is taken from two deep lakes, one of 2,300 acres area, and having an elevation of 32 ft. above the other, whose area is 460 acres. These are now being connected by a tunnel, 9 ft. wide by 9 ft. in height, and nearly 2½ miles long. Across the outlet of the lower lake a concrete dam is being constructed, 350 ft. long and 50 ft. high, and arrangements have been made to bring ten pipe lines from the dam, but only three lines will be completed at present. Each steel pipe line will be 1,600 ft. long, 48 in. in diameter at the upper end, 44 in. in the middle section, and 42 in. at the power-station. There will be three sets of Pelton wheels, each to develop 3,000 h.p. at 200 r.p.m. under the effective head of 390 ft., and one set of 200-h.p. wheels for driving the exciters at 580 r.p.m. Each of the main units will consist of two overhung wheels, one mounted on each end of the shaft of a 1,500-kw. Westinghouse rotating-field generator, 2,200 volts, 60 ∿. The most interesting feature of the equipment is stated to be the single combination deflecting and needle-regulating nozzle provided for each water-wheel, fitted with a high-pressure ball joint, which is leather-packed and rocks on forged steel trunnion bolts. Load and speed variations can be made, independent of any change of velocity in the pipe lines, by deflecting the nozzle by governor or hand. The shaft of each unit is 13 in. in diameter. The two exciters (each 80 kw.) with their wheels are mounted on a common bedplate with a 120-h.p. induction motor between them. The motor leads are connected to the main bus-bars, and normally the motor runs

Digitized by Google

at synchronous speed, taking no current and doing no work, but should the exciter wheel nozzle become clogged and fall off in speed, the motor at once takes the current and drives the exciter until the clogging has been removed by the attendant. The transmission line to Vancouver is 16 miles long, and has to cross a navigable channel with a span of 2,800 ft. On one side two steel towers 140 ft. in height will be erected to support twelve steel cables, which on the opposite side, where there is high ground, will be supported on poles. Two independent transmission lines, each of two three-wire circuits, will be laid together for part of the way, ultimately branching off one to Vancouver, one to Burnaby. The pressure will be 20,000 volts. W. C. H.

914. *St. Gilles Electric Power Station, Brussels.* **F. C. Perkins.** (Elect. Rev. N.Y. 41. pp. 882–884, Dec. 27, 1902.)—This power-house is used in connection with the tramways in Brussels. The boiler-house contains four Galloway boilers, constructed in Belgium, 2·2 m. in diameter, working at 8·5 atmospheres pressure, and giving 1,500 kg. of steam per hour. There is also a Green's economiser of 288 tubes, and a chimney 36 m. high and 2·15 m. in diameter. The engine-room contains three horizontal, tandem-compound engines by van der Kerchove, and with a cut-off at 28 per cent. of the stroke and a steam pressure of 8 atmospheres, 550 h.p. is developed, the diameters of the cylinders being 430 and 740 mm., and the stroke 1 m. These engines drive shunt-wound machines, which are used in connection with accumulators, the pressure being variable between 500 and 600 volts, and the output about 300 kw. The accumulators, which are charged through a motor-generator booster, are 2½ km. from the power-house, and consist of 270 cells, having a capacity of about 500 kw. for one hour. W. H. S.

915. *Cincinnati, Georgetown, and Portsmouth Electric Railway.* **E. M. Stevens.** (Elect. Rev. N.Y. 42. pp. 464–467, April 4, 1903.)—*System:* High-pressure three-phase transmission to converter substations; 600-volt overhead trolley line construction. The *boiler-room* contains six Cahall boilers of 1,500-h.p. capacity. The feed-water is heated by a large Stilwell-Bierce heater. Coal is tipped from railway wagons direct into bunkers alongside the boiler-house. The *engine-room* contains two cross-compound condensing Hamilton engines, with cylinders 24 and 44 in. in diameter, 42 in. stroke, running at 90 r.p.m. A central condensing plant is provided. Each engine drives directly a Westinghouse 600-kw. three-phase alternator, working at 360 volts, 25 ∿. Six 200-kw. transformers raise the pressure to 15,000 volts for transmission to the substations. There are also, in the power-station, two 50-kw. exciters, severally driven by a steam engine and an electromotor, and two rotary converters of 250 kw. each. There are three substations, each at the middle of 10 miles of railway; one of these contains two 250-kw. converters, and the others each two 150-kw. converters, with step-down transformers and switch-gear. These also serve as passenger stations. The trolley wires, of No. 000 wire gauge, are supported by span wires. The rolling stock consists of ten 50-ft. cars, each equipped with four 60-h.p. Westinghouse motors; twelve 40-ft. cars, and forty-three other cars of various descriptions. A large passenger and goods traffic is handled. The railway was formerly operated by steam; it has been converted from narrow to standard gauge, and relaid with heavier rails. The total length of railway amounts to 50 miles, and large extensions are in progress. The article is illustrated.

A. H. A.

Digitized by Google

916. *Jungfrau Railway.* **A. Sidler.** (Zeitschr. Elektrotechn., Wien, 20. pp. 589–593, Nov. 30; 606–610, Dec. 7; 621–624, Dec. 14, and pp. 638–641, Dec. 21, 1902.)—The concession for an electric railway up the Jungfrau was obtained in 1894, and work was begun in July, 1896. Water rights for the line have been taken in both the White and Black Lütschine. The former has a flow of 15 cub. m. per second, of which only 6 cub. m. are utilised at present. The effective head is 85·5 m., giving 2,650 h.p. in all. There are two Girard turbines giving 500 h.p. each, and two Francis turbines of 800 h.p. each, all connected by Zodel couplings to Oerlikon three-phase generators. There are two 25-h.p. turbines coupled to exciters. The Black Lütschine would give 9,000 h.p., but is not at present employed, being kept in reserve for extensions. The following are the principal data as to the length and gradients of the different sections of the line :—

Stations.	Height.	Distances in m.		Maximum Gradient, per cent.
		From Start.	Station to Station.	
Kleine Scheidegg ...	2,064 m.	—		
Eiger Glacier	2,328	2,015	2,015	24·1
Rothstockwand	2,530	2,880	865	25·0
Eigerwand	2,812	4,100	1,220	25·0
Eismeer	3,156	5,660	1,560	25·0
Jungfraujoch	3,421	9,220	3,560	6·7
Jungfrau	4,093	12,200	2,980	25·0
Summit	4,166	12,200	Vertical lift. 78 metres.	

As far as the Eigar Glacier only 87·4 m. is in tunnel. Thence the line is entirely in tunnel, which is 8·7 m. wide and 4·35 m. high, having a section of 14·6 sq. m. Being in rock, the tunnel is not lined. The line is opened as far as the Rothstockwand, where there is a chamber in the rock for the machinery for boring the next section, consisting of rotary converters for the Marwin rock drills and a fan motor. The track is laid with steel rails on iron sleepers. The rails are 100 mm. high, 90 mm. wide at the base, and 46 mm. at the top, weighing 20·6 kg. per m. The gauge is 1 m., widened 2 mm. in curves of 150 and 200 m. radius, and 4 mm. in curves of 100 m. radius. The rack, of the Strub type, has a pitch of 100 mm., and weighs 84 kg. per m. It is made with a widened head to allow the use of guides to prevent the pinion mounting the teeth.

High-tension line.—The overhead line from the water-power station in Lauterbrunnen to the Eiger Glacier consists of three hard copper wires of 7 mm. diameter, calculated to carry the whole power of the Lütschine at 7,000 volts with a loss of 8 per cent. It is carried on wooden masts 12 m. high.

Transformers are placed in every station of the line. They are of the three-core, three-phase type, and transform down to 500 volts.

Trolley wires are 9 mm. diameter, and are suspended at a height of 4 m. from the rails by means of 6 mm. steel wire.

The *locomotives* form the hinder bogies of the cars, which are attached to them by swinging bolsters. Each locomotive has two six-pole, three-phase motors, giving 120 h.p. each at 750 r.p.m., with 450–500 volts and 38 periods per second. After three hours' run at this load no part of the motors exceeded the air temperature by more than 25° C. The motors have ring

Digitized by Google

lubrication, and weigh 2,100 kg. each. At full load the efficiency is 92 per cent., the power-factor 90 per cent., and the slip 1·5 per cent. The maximum torque is 860 kgm., the normal torque being 115 kgm. The stators have an outer diameter of 870 mm., an inner diameter of 600 mm., and a width of 240 mm. The air-gap is 1·2 mm. The motors drive through double reduction helical gearing with a ratio of 12·66 : 1. The main pinion has a pitch circle diameter of 700 mm., so that the normal speed of 750 r.p.m. on the motors corresponds to a speed of 7·7 km. per hour for the locomotive. Each locomotive has three brakes, any one of which will hold the train. Two are ordinary brakes working on the main pinion. The third is a band brake applied to the motor shaft, and is automatically put on when the current fails or when the speed exceeds a certain limit. Water-cooling arrangements are provided for making a long descent on the brakes. In normal working the descent is effected in either of three ways : (1) By switching the motors to run downhill, when they will work as generators. This is open to the objection that if no ascending train is on the line the turbines will race, and cumbrous and wasteful resistances at the power-house must be used to take up the power. (2) By switching the motors to run *uphill* and increasing the rotor resistances till they run down. This is wasteful, as they take power from the line and dissipate it, together with the energy of the descending train, in the resistances. (3) By exciting the motor stators from a small direct-current machine on the shaft of one of them. The motors then work as ordinary synchronous generators, and the power is absorbed in resistances which are cooled by a fan. This method has the advantage of being quite independent of the trolley line. The following readings were taken with a locomotive weighing 13·4 tons with cars making a total of 27·6 tons.

TRAIN ASCENDING.

% Gradient.	Km. per hour.	Tension.	Current in each Motor.
9·5	8·1	500 V	60 A
21·5	7·8	500 V	109 A
24·1	7·8	500 V	123 A
25	7·75	490 V	133 A
24·1	7·75	565 V	110 A

DESCENT WITH MOTORS SWITCHED FOR DESCENT. (Method 1.)

24·1	8·5	570 V	60 A

DESCENT WITH DIRECT-CURRENT EXCITATION. (Method 3.)

% Gradient.	Km. per hour.	Tension.	Exciting Current.	Motor Current.
25	8·25	270 V	130 A	32 A
7	4	75 V	50 A	5 A
12	5	150 V	70 A	13 A
24·1	7·5	250 V	120 A	28 A
24·1	8	260 V	120 A	31 A
24·1	7	250	120 A	32 A
21·5	8·1	250	110 A	22 A

[See also Abstract No. 933 (1899).] A. E. L.

917. *Milan-Gallarate-Porto Ceresio Electric Railway.* **de Marchena.** (Soc. Int. Élect., Bull. 3. pp. 180–224 ; Discussion, pp. 224–227, with Appendix by **Boucherot,** pp. 255–256, April, 1903.)—In order to meet growing and

Digitized by Google

keen competition, the Mediterranean Railways Company found it necessary to adopt electric traction on the railways between Milan and Lakes Maggiore and Lugano [see Abstract No. 2294 (1901)]. The total length of double track, between Milan and Gallarate, is 40 km., and of single track, between Gallarate and Porto Ceresio, Laveno, and Arona is 100 km. Power is supplied to the trains by direct current at 650 volts, conveyed by a third rail fed from five substations. Only the Milan-Gallarate-Porto Ceresio route was electrically equipped at the time of writing the article.

The generating station is situated at Tornavento, on the river Ticino, and is operated by steam. There are eight boilers, each having 250 sq. m. of heating surface, and two economisers having a heating surface of 540 sq. m. each. The boilers are of the Tosi multitubular type, working at 180 lbs. per sq. in. absolute, and evaporating normally 8,000 lbs. of water per hour each. The steam piping forms a ring main, with the boilers connected to one link, and the engines to the other. There are three main generators and two auxiliary sets. Each of the former consists of a horizontal tandem compound Tosi engine of 1,500 h.p. with one crank, direct coupled to a three-phase alternator of 750-kw. output. The engine cylinders are 725 and 1,200 mm. in diameter, with a stroke of 1,350 mm., and the speed is 94 r.p.m. The fly-wheel is 5·5 m. in diameter and weighs 37 metric tons. Each engine is provided with its own air-pumps, direct driven, and condenser. The auxiliary engines are of the vertical type, running at 270 r.p.m., and each is directly coupled to a dynamo of 75-kw. output at 125 volts. The main alternators are of the stationary-armature type, having 32-pole fields, and generating current at 13,000 volts, 25 ∿. There are 192 slots in the armature core, containing 96 coils. The generators run well in parallel, without amortisseurs. The daily output varies from 12,000 kw.-hours in winter, to more than 18,000 in summer, averaging 14,000 per day. The variations of load sometimes amount to 100 per cent., the maximum being 2,200 kw., momentarily. The consumption of coal is about 3·3 lbs. per kw.-hour measured at the switchboard; the mean cost of production is 0·62d. per kw.-hour.

Two transmission lines leave the works, each consisting of six conductors, 9 to 4 mm. in diameter, carried by insulators on wooden poles 45 m. apart. The only interruption of the line recorded was due to lightning discharges. The three principal substations each contain seven transformers and two 500-kw. rotary converters giving direct current at 650 volts, at 500 r.p.m. High-pressure automatic oil-break switches protect the sub-stations on the incoming side. The substations are connected in parallel on the direct-current side, as well as by the alternating-current mains, and automatic switches have been provided to prevent reversal of the converters in case of short-circuit on the high-pressure side. The remaining substations are each provided with a rotary converter and transformers of 250-kw. output, and a battery capable of discharging at 600 amperes for a short time. One of the larger substations (next Milan) has also been equipped with a battery capable of giving 1,000 amperes. The maximum momentary load at this substation is 1,000 kw. The average efficiency of transmission is 82 to 85 per cent.

The tracks are equipped with rails weighing 37 kg. per m., connected by copper bands of 63 sq. mm. cross-section. The third rail weighs 45 kg. per m., and is bonded with 200 sq. mm. copper; it is divisible at switch pillars into sections 3 km. long, and is supported by insulators of reconstructed granite, 4 m. apart. The rail is unguarded, except at stations and near level

Digitized by Google

crossings. The loss by leakage is insignificant. The third rail is mounted 67·5 cm. from the inner edge of the track rail, and 19·8 cm. above the level of the latter.

The rolling stock, electrically equipped, consists of twenty motor-cars, twenty trailers, and a locomotive. All the cars are of the bogie type, carrying 75 to 90 passengers each; the motor-cars are provided each with four series-wound motors of 160 h.p., geared to the driving axles. The wheels are 1·05 m. in diameter, and the speed ratio is 1·96. Each motor with its gear wheels weighs 2,500 kg. Series-parallel controllers are fixed at both ends of each motor car. Compressed air is used for the brakes. The speed normally attained is 75 to 80 km. per hour, with a train weighing 75 to 90 metric tons; the power absorbed at starting is 400 or 500 kw., falling to 240 kw. at 90 km. per hour, and 100 kw. at 60 km. The whole line is traversed at a mean speed of 60 km. per hour, including stops, and the mean energy absorbed is 50 watt-hours per ton-kilometre. Several trains equipped on the multiple-unit system are to be put in service. Figures are given showing the enormous increase in the traffic since the adoption of electric traction, with lower fares. The concluding section of the paper consists of a critical comparison between the various known systems of electric traction, to the disadvantage of the three-phase high-pressure system. In the *discussion*, **Korda** defended the latter, pointing out that no interruption had taken place on the Lecco-Chiavenna line since its inauguration in October, 1902, and that when long lines were in question the economy in capital cost of the three-phase system, amounting to 30 or 40 per cent., became very important. In a supplementary note, **Boucherot** further defends the three-phase system against a suggestion that it possesses serious disadvantages with respect to the starting of trains as compared with the direct-current system.

A. H. A.

918. *Mersey Tunnel Electric Railway.* (Tram. Rly. World, 13. pp. 323–335, April, 1908.)—The tunnel was originally constructed in 1886 and operated by steam locomotives, but owing to the foul atmosphere resulting therefrom, which could not be overcome, the railway was financially unsuccessful. In 1901 its conversion to electrical working was commenced, and the new service began in 1903. The main tunnel is 26 ft. wide and 19 ft. high, lined with brick in cement; there are also a ventilation tunnel and a drainage tunnel of smaller dimensions. The track was relaid with 86-lb. rails to 4 ft. 8½ in. gauge, and two conductor rails were provided, supported by earthenware insulators fixed on the sleepers. The positive rail is raised above the running rails and is 20½ in. outside them; the negative is in the centre of the track, at a lower level than the positive.

The conductor rails are connected across the joints with copper bonds, and are of two weights—100 and 60 lbs. per yard. Coal is brought to the generating station in railway wagons, and is broken up by an electrically driven crusher, after which it is carried by a bucket chain conveyor to bunkers of 600 tons' capacity. The boiler-house contains nine Stirling boilers, each having 4,370 sq. ft. of heating surface, and working at 170 lbs. per sq. in. The chimney is 250 ft. high and 13 ft. diameter inside. The boilers are fitted with Roney mechanical stokers, and economisers are provided, as well as a Harris water-softening plant; the feed-water is heated to 212° F. before entering the boilers. Condensed water is returned from the steam pipes to the boilers by the Holly system. A central condensing plant is provided for all the engines. The generating plant consists of three vertical compound steam engines

Digitized by Google

directly coupled to double-current generators, the whole being of Westinghouse manufacture. The cylinders of each engine are 30 and 60 in. in diameter, with a stroke of 48 in., and the speed 94 r.p.m. Each of the generators is rated at 1,250 kw. at 650 volts direct current, and also produces three-phase alternating current at 25 cycles per second, having 32 field magnet poles. Two smaller Westinghouse sets, of 200 kw. each at 650 volts, 250 r.p.m., are provided for lighting the railway stations and for small traction loads. There is also a motor-driven booster used for automatically charging and discharging a battery of 320 Chloride cells. The main switchboard consists of 19 panels, mounted on a gallery 12 ft. above the floor.

Ten main feeders, of the B.I.W. lead-covered, paper-insulated type, are led from the power-station through the ventilation tunnel to feed the line. The rolling stock consists of 24 motor cars, seating 48–50 passengers, and 33 trailers, seating 60–64. Each motor-car is fitted with 4 motors, one on each axle of the two bogie trucks, giving a total of 400 h.p. Collector shoes are provided at both sides and both ends of each car, and make contact with the conductors by gravity. The controllers are of the Westinghouse electro-pneumatic type, operated from either end of any motor car. The couplings are of the automatic Buhoup type. The speed has been considerably accelerated, the longest journey being reduced in time from 15 to 11 minutes, and a three-minute service is given. Hydraulic passenger lifts are used, the water being pumped into tanks 130 ft. from the ground by automatically controlled electrically driven pumps. The article is fully illustrated. A. H. A.

919. *South Lancashire Tramways System.* (Elect. Engin. 31. pp. 474–480, April 3, and pp. 514–517, April 10, 1903.)—*System:* 7,000-volt, 50-cycle, two-phase system for transmitting power to outlying substations. The main power-station is at Atherton. The *boiler-room* contains four Lancashire boilers, each 38 ft. by 8½ ft., working pressure 160 lbs. per sq. in. Each has two furnaces 3 ft. 5 in. in diameter. The size of boilers is somewhat unusual, but special advantages are claimed, due to large size of furnaces and flues, whereby complete combustion of fuel is effected. The feed-water is heated by Green's economiser, consisting of three groups of 120 pipes, with each group connected by copper expansion pipes. Condensed steam discharged into feed-tank; exhaust from boiler feed pumps discharges into feed-water storage tank. Coal is fired by mechanical stokers, Whittaker and Benniss types. Provision for hand firing if necessary. The *engine-room* contains two vertical cross-compound type engines, 25·6 in. and 33·5 in. by 33·5 in. stroke, rating 725 b.h.p. at most economical load and 920 b.h.p. at maximum continuous overload; 100 r.p.m.; 1 ditto for traction generator d.c. One vertical cross-compound engine 19 in. and 30·3 in. by 25·6 in. stroke. Two sets condensers, surface type, each evaporating 19,000 lbs. steam per hour. Each engine drives directly two 50-cycle, two-phase alternators of 500–625 kw. output at 7,000 volts, at 100 r.p.m., with rope-driven exciters. Two c.c. railway generators, of 500 kw. and 250 kw. respectively, 500 volts no load, 550 full load. One 250-kw. motor generator. Boosters: (*a*) one positive feed, 56 kw.; (*b*) two negative feed, 8 kw.; (*c*) one milking, 240 amperes; (*d*) one reversible, 40 kw. Feeders of h.t. in stoneware pipes, l.t. on solid system in troughs. H.T. feeders have three conductors with common return; two conductors as twin cable with return encircling. H.T. section area 0·025 sq. in., 0·025 sq. in., and 0·035 sq. in., for working pressure of 7,500 volts per phase. L.T. feeders vary from 0·075 sq. in. to 0·8 sq. in. All cables paper-insulated and lead-

Digitized by Google

covered. The station is equipped with 240 Tudor cells, capacity 265 amperes for six hours, 981 amperes for one hour, 1,400 amperes for short periods. The track is equipped on the overhead system, side poles, supported by means of brackets. Trolley wire of best hard-drawn copper, 0·409 in. diameter, insulated by standard ¾ in. West End type, Ætna double insulation. The rails are of girder (6 in. deep) type, 90 lbs. per yard, tied together by wrought-iron ties. The fishplates weigh 38 lbs. per pair. The foundation of the track is Portland cement concrete, 6 in. deep, across entire width. The track is paved to 1½ ft. on either side of the line with granite setts resting on gravel foundation. There are 50 motor cars fitted with trucks, standard Witting 30-h.p. motors rated at 1,000 lbs. draw-bar pull at 10 miles per hour, with Witting controllers—without magnetic blow-out. The motor cars have a capacity of 55—22 in and 33 out—passengers.

The South Lancashire Tramways afford intercommunication between the thickly populated industrial districts of South Lancashire. A peculiar feature is the carrying of goods at night, while a parcels service has also been instituted. Special workmen's cars are run. A noticeable feature in connection with the track construction is the adoption of the method of laying recommended by Yorke after his visit to America, consisting of the provision of longitudinal sleepers under the rails. This method conduces to noiseless running, and greatly reduces vibration. The points used have a distinctive arrangement, adopted to prevent the tongue from rocking at the hinge. In the recess at the ball end, a mild-steel bush is introduced, machined to fit the tongue, while a lug on each side of the tongue makes it impossible for the latter to work out of its proper position. W. J. C.

920. *Huddersfield Electric Tramways.* (Tram. Rly. World, 18. pp. 336–345, April, 1908.)—The article describes the extensions carried out since 1901, the total length of track electrically equipped being now 36 miles. [See also Abstract No. 1429 (1901).] A new generating set has been installed, consisting of a Combe-Barbour engine of the vertical compound type, directly coupled to a Mather and Platt 10-pole dynamo of 650 kw. at 550 volts, 90 r.p.m., capable of giving 845 kw. for two hours. The engine has cylinders 22 and 44 in. diameter, stroke 42 in., and is designed for an initial pressure of 160 lbs. per sq. in.; the air pumps for the jet condenser are direct driven. The flywheel is 19 ft. in diameter, and weighs 38 tons. The steam consumption is 18 lbs. per i.h.p.-hour at full load. There are seven motor-driven boosters for the return feeders, excited by the corresponding line feeders. A new Lancashire boiler, 30 ft. long × 8 ft. 6 in. diameter, with Vicars mechanical stokers, has been installed, together with a Musgrave superheater and a Green economiser of 3,840 sq. ft. heating surface. The trolley wire is of No. 00 B. & S. gauge, and there are no distributors; side-pole bracket suspension is used. The cars are fitted with two Westinghouse motors each, and are provided with covers over the upper decks. Specially rigid joints are used for the track. The article is accompanied by numerous illustrations. A. H. A.

921. *Hampton Court Electric Tramways.* (Electrician, 51. pp. 14–17, April 24, 1903.)—This is a new loop-line between Twickenham and Hampton Court, and passes through Hampton and Molesey on the one hand, and Kingston and Teddington on the other. At the generating station there has been installed a new 1,000-kw. set, consisting of an Allis cross-compound engine, running at 94 r.p.m., directly coupled to a British Thomson-Houston

Digitized by Google

three-phase alternator, which is situated between the cylinders of the engine and generates current at 5,000 volts and 25 ∿. From the power-station, current is transmitted by means of a three-core cable, each core having a section of 0·079 sq. in. The cable is duplicated, but both are continually used in ordinary working. On arriving at the substation, the current is received by oil-cooled single-phase transformers, and is stepped down to 420 volts. The transformers are mesh-connected, and each set of three is in a separate cell. Each transformer has a capacity of 200 kw., and it is possible, by means of a three-way switch which is mounted on a marble base on one side of the transformer, to vary the ratio of transformation, thus obtaining complete control over the pressure on the line. A two-way switch on the switchboard enables the attendant to connect the rotary to either the whole of the secondary winding or only half. This arrangement is used when starting up ; the switch is thrown over to the half-winding contact until the machine has run up to speed, when it is put on to the full winding. It is said that all objectionable surgings and transformer effects are eliminated by the use of the half-winding at starting. There are three six-pole, six-phase rotary converters of standard B.T.H. type, each having a capacity of 500 kw. They run at 500 r.p.m., and 25 ∿, and generate 500 to 550 volts on the continuous-current side. A series-wound booster is employed for regulation of the line voltage, and the fields of the motor of this machine are excited from a distant point of the line. F. B.

922. *Colorado Springs Electric Tramways.* **J. H. Rusby.** (Elect. Rev. N.Y. 42. pp. 577–579, April 25, 1903.)—*System :* High-pressure three-phase transmission, and direct supply at 575 volts to tramways. The *boiler-room* contains six Cahall water-tube boilers, of 300 and 400 h.p. The chimney shaft is of steel, 184 ft. high and 10 ft. in diameter. The feed-water is heated by a large Cochrane heater. Coal is stored in bins by means of mechanical conveyors. The *engine-room* contains two Allis engines with cylinders 28 in. in diameter and a stroke of 46 in., direct coupled to General Electric 10-pole dynamos of 500 kw. output at 575 volts ; one engine with cylinder 22 in. diam., 42 in. stroke, direct coupled to a dynamo of 300 kw. at 575 volts; and one engine with cylinders 18 and 32 in. in diameter, 42 in. stroke, driving directly a 300-kw. three-phase alternator at 100 r.p.m., 6,600 volts, 60 cycles per second. There is also a steam-driven exciting set of 35 kw. There are 30 large motor cars fitted with Brill, and Milwaukee trucks, and four G.E. motors each, giving 152 h.p. per car, and about 40 smaller cars of various kinds. The article is illustrated. [See also Abstract No. 794 (1903).]

A. H. A.

923. *Pittsburg Street Railway System.* (Street Rly. Rev. 13. pp. 185–198, April, 1903.)—The Pittsburg Railway Company operates all the electrical railways in Allegheny County. The total car mileage for 1892 amounts to 33,065,754·89, and the number of passengers carried is 159,772,540. The Company has 403·36 miles of track measured as single line. *Track and overhead construction :* Girder tram-rails are laid on 6 in. × 8 in. × 8 ft. ties. The present standard trolley wire is No. 00, and this size is used for all renewals. Iron poles are used and are set 125 ft. apart, with a rake of about 7 in. ; these are made of three sections, 5, 6, or 7 in., or 4, 5, and 6 in. with swedged joints 18 in. long, and capped on top. The feeder lines are practically all overhead, and are partly of copper and partly of aluminium, excepting that, from the 20th Street power plant, a tunnel is extended under Pennsylvania

Digitized by Google

R.R. tracks to Liberty Street, and thence to Penn Ave. There are eight generating stations, the positions of which are indicated on a map. Detailed descriptions are given. *The cost of power* at the various stations, based on data taken in 1901, was as follows :—

Station.	Annual Output. Kw.-hour.	Cost per kw.-hour in cents.
Manchester	10,120,840	0·496
Birmingham and Suburban	11,877,366	0·680
Glenwood	8,190,230	0·656
20th Street	33,183,432	0·676
Allegheny and Glenwood (lighting)	17,138,437	0·882

Soon after the Company began operating the present system, it was found necessary to put in a larger generating station, and one is at present being erected designed for 9 units of 1,500-kw. capacity each. Six of these will consist of horizontal cross-compound engines, with cylinders 32 and 62 by 54 in., coupled direct to Westinghouse generators, giving direct current at 550 volts, and two 2,000-volt two-phase alternators. The station is designed on the unit system, there being two batteries of two boilers for each engine, and each group of four boilers is served by a separate stack 130 ft. high. Each set of four has its own auxiliary steam apparatus in the same space as the engine and its generator. F. B.

924. *Electric Power at the Vulcan Shipbuilding Yard, Stettin.* **A. Böttcher.** (Zeitschr. Vereines Deutsch. Ing. 47. pp. 109–115, Jan. 24; 153–160, Jan. 31; 231–237, Feb. 14; 311–318, Feb. 28, and pp. 410–415, March 21, 1903.)—Power is supplied by three-phase alternators of 500-kw. capacity. A portion of the power is transformed to direct current by means of rotary converters, five of which are in the power-house and two in a substation, each having a capacity of 76 kw. Details and accessories of all kinds are fully described. In view of the possibility that some of the motors would be found to be too large or too small, arrangements were made by which the change could be effected without difficulty. On the surface of the foundations of each motor, a pair of channel irons were so placed that the motor could be directly bolted to them. In case a change was necessary, a piece of boiler plate, 15 mm. thick, was bolted to the channel irons, and in this boiler-plate holes were made to receive the bolts of the new motor. Sliding rails and tightening bolts were used as little as possible. Belts were, however, in general, preferred to toothed gearing as a method of reducing the motor speed. W. H. S.

925. *Electric Motors in a Sugar Refinery.* **E. J. Brunswick.** (Génie Civil, 42. pp. 397–401, April 18, and pp. 417–422, April 25, 1903.)—The refinery is at Cambrai, and power is supplied by triphase current of three different frequencies, viz., 50, 35, and 21 $\sim$. The object of this arrangement is to utilise the kinetic energy of a series of sugar-turbines, which have to be started and stopped every 4 min., and run at 1,000 r.p.m. with a load of between 200 and 300 kg. of sugar. The motors driving these machines have two concentric squirrel cages buried in the same core plates. The outer squirrel cage has a low reactance and high resistance; the inner one has high reactance and low resistance. In this way the starting torque is kept high

Digitized by Google

without excessively reducing the torque at full load, the ratio of the two being 58 to 15. The motor is started and run up to full speed by an alternator giving a current at 50 ∿, there being no brushes, sliding rings, or starting resistance. When it is desired to stop the motor, it is first switched on to a 85-cycle circuit, and then to a 21-cycle circuit, furnishing in turn power to both of them, after which it is reduced to rest by a mechanical brake. Current at the lower cycles is furnished by alternators to other motors in the buildings. The article contains details as to the construction of motors and generators, together with diagrams illustrating the methods of control.

W. H. S.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

926. *Standardisation of Tramway Rail Sections.* **W. Howard-Smith.** (Tram. Rly. World, 18. pp. 353–355, April, 1903.)—This is an account of the work of the Engineering Standards Committee, so far as it refers to the sections of tramway rails. The following are the sizes agreed upon, which have received the approval of the Board of Trade. It is recommended that there shall be five British Standard ("B.S.") tramway rail sections, varying from a minimum of 90 lbs. per yd. to a maximum of 100 lbs. per yd., in gradations of 5 lbs. per yd., and of the following general dimensions :—

	Height.	Width of Flange.	Normal Weight.
No. 1. "B.S." Section.....	6½ in.	6½ in.	90 lbs. per yd.
2. „	6½	7	95 „ „
3. „	6½	7	100 „ „
4. „	7	7	105 „ „
5. „	7	7	110 „ „

For each of these sections, a slight modification is proposed to be made in the special rails to be used on curves of one chain (or less) radius, the groove being widened by one-eighth of an inch, and the guard or lip made thicker, to provide for the special character of the wear. These special sections will be known by the affix "C" (meaning curve), thus :—

	Height.	Width of Flange.	Normal Weight.
No. 1. C "B.S." Section.....	6½ in.	6½ in.	96 lbs. per yd.
2. C „	6½	7	101 „ „
3. C „	6½	7	106 „ „
4. C „	7	7	111 „ „
5. C „	7	7	116 „ „

Throughout these sections the rail groove is to have a width of 1⅛ in., with a depth of 1⅛ in., measured from the top of the lip or guard, but for "curve" rails the width of the groove is increased to 1¼ in. An unusual feature is that, in these sections, the rail web is not to have parallel sides, but to be tapered, which is considered to make the rail much stiffer and to have other practical advantages.

F. B.

[1] Non-electrical Automobiles are described in the Section dealing with Steam and Gas Engines.

Digitized by Google

927. *Wear of Tramway Tyres.* **A. Spilberg.** (Soc. Belge Élect., Bull. 20. pp. 26–89, Jan.; 78–83, Feb.; and pp. 125–144, March, 1903.)—This paper deals with the unequal wear of the tyres of electric tramway wheels, pointing out the various causes which lead to irregular and excessive wear, and the corresponding remedies. The author's experiments and observations were made in Brussels; the rails are of 1-metre gauge, mostly double track, with overhead trolley wires. The cars are of the "Franco-Belgian" type, with two axles, each driven by a series motor, with series-parallel control. The motors are hung on springs, parallel to the axles, which they drive by spur-gearing. The first part of the paper contains a number of drawings showing, to scale, sections of the tyres of each of the four wheels of a selected number of cars, after runs varying from 18,500 to 87,500 km., a section of the tyre when new being also shown on each drawing in dotted lines. Thus the character and amount of the wear of each tyre are clearly shown. The drawings are from impressions made in wax by the actual tyres. They are seen to range themselves in two classes: (1) in which the tyres of the wheels *on the same side* of the car are similarly worn, on the inside or the outside of the flanges as the case may be; and (2) in which the tyres of wheels diagonally opposite are similarly worn. In (1) there is a force normal to the track, and acting more or less at the centre of gravity of the car, pressing it against one rail and away from the other; in (2) there is a couple, tending to produce a movement of rotation. The author investigates the causes of these parasitical forces, and finds that they can be accounted for by want of symmetry in the suspension or gearing of the two motors, or in the motors themselves. Thus a couple would be produced, causing similar wear diagonally, if the armature spindle of one motor were hung at a different level from that of the other (the axles of the two pairs of wheels being assumed to be at the same level with each other); or if the efforts exerted by the two motors are not identical; or if one wheel of a pair is larger than the other, so that the axle is out of level. Diagrams of class (1) would result from the two axles being both out of level, in the same sense. In some cases, but not all, reversing the direction of running of the car is a cure for these irregularities of wear. Further, the author proceeds to show that not only is absolute equality in the diameters of the wheels on one axis absolutely necessary—a result which follows from what has been said—but also that the wheels on the different axles of the same car should also be of exactly the same size. For otherwise, with series-wound motors, the alternatives are skidding of the wheels on one axle, or unequal speed of the two motors, which means unequal amounts of power applied to the two axles, and hence, as before shown, unequal wear.

The last part of the paper, which is well illustrated throughout, deals with the different methods of manufacture of tramway and railway tyres, the materials employed, and the tests to which the raw material and the finished tyres are subjected. In this connection a table is given of the various tests specified by twenty-one Continental railway companies for the tyres of their rolling stock. B. P. S.

928. *Method of Testing Rails.* **C. Frémont.** (Comptes Rendus, 136. pp. 85–87, Jan. 5, 1903.)—The usual drop test, as a means of ascertaining the flexibility of a rail, is of importance theoretically, seeing that, if the metal is too soft, the rails rapidly lose shape; on the other hand, if not possessing sufficient resistance, fractures are likely to occur when the rails are in actual use. Between theory and practice, however, there is a wide difference. For example, in a trial of flexibility it is assumed that the rails are homogeneous,

Digitized by Google

a maximum deviation being imposed, and the weight and height of the fall arranged so as not to break the rail being tested. Rails are seldom homogeneous, and it is this want of homogeneity which causes the discordance between the trial results and results arrived at in practice. It is generally in the centre of the rail that any defect occurs, and the ordinary drop test fails to reveal its presence, as the exterior is generally of good quality. The author suggests that the test should be performed on the central part of the flange side of the rail. His method is to operate on segments of rail 50 cm. in length, on which the flange is cut centrally, in the direction of the length, with an incision 60 m. in length, which is widened out to form two cavities, at the ends, of 15 mm. radius, penetrating to the centre. Each part thus prepared is poised on two bearings 40 cm. apart, consisting of two steel chairs of a semi-cylindrical form 14 mm. in diameter. The hollowed surface being turned downwards, the rail receives the shock of a hammer, falling from a height of 5 m., with sufficient force to break it even if of metal of the best quality. After breaking, the two fragments are joined, and the standard of the metal is judged, either by the lengthening which takes place in the hollowed portion or by the angle of the flexure produced. The extent of the impression left on the bearing supports also helps in the determination of the force used in causing the breakage. C. E. A.

929. *Microstructure of Axle Steel.* **H. Fay, A. W. Higgins, and F. W. Coburn.** (Technology Quarterly, 16. pp. 4–17, March, 1903.)—This paper deals with the microstructure, heat treatment, and physical properties of axle steel. The steel examined contained C 0·41 ; Mn 0·58 ; Si 0·023 ; S 0·084 ; P 0·037, and had a tensile strength of 95,500 lbs. per sq. in., which was almost always lowered by simple heat treatment ; this high tensile strength had probably been attained by working the metal whilst cooling from 1,000° to Ar_1 (670°), and so preventing the formation of crystals. A slight increase of tensile strength was obtained by heating at 1,000° and cooling in air, but cooling in the furnace produced a decrease of tensile strength which was greater at 1,000° than when the heating was only carried out at 970–650° ; at the lower temperature the decrease of tensile strength was only about 8 per cent. The decrease of tensile strength is usually associated with an increase in the size of the crystal particles, but a high tensile strength does not necessarily indicate a good steel, for the one specimen that showed an increase by heat treatment was in parts very coarse and would have been easily damaged by shock. T. M. L.

930. *Schedule Speeds on Electric Railways.* **W. Park.** (Tram. Rly. World, 18. pp. 238–240, March, 1903.)—Where stops are frequent, as is generally the case on a suburban line, the schedule speed is largely dependent on the acceleration of the train when starting. The multiple unit system of electric traction, by permitting the weight of the coaches and passengers to be utilised to obtain adhesion, lends itself to rapid acceleration in a way that is not possible by the locomotive system. Curves are given, four of which show respectively the effect on the schedule speed of four variables, viz., maximum speed, rate of acceleration, amount of coasting, and rate of braking. When the number of stops per mile is fixed, and also the duration of the stop, an increased schedule can only be obtained by increased consumption of energy, so when stops are frequent it becomes an expensive matter to maintain a very high average speed. The starting currents are heavy, necessitating motors of large capacity. Coasting is not permissible, and the brakes must be

Digitized by Google

applied immediately the current is cut off, and a rapid rate of retardation maintained. Such conditions materially increase the cost of maintenance, and the efficiency of the system is very low. Experience of British and American engineers proves that when the stops average about two per mile, the maximum satisfactory schedule that can be maintained throughout the day is from 16 to 17 miles per hour. F. B.

931. *Third Rail Traction* (Elect. World and Engineer, 41. pp. 389–391, March 7, 1903.)—A description of a hooded third-rail system in Pennsylvania, between Wilkesbarre and Hazleton. Owing to the character of the country traversed, some heavy engineering was necessary, including the driving of a tunnel, 2,600 ft. long, through Penobscot Mountain, about 600 ft. below the summit and through solid rock. This was in order to eliminate steep gradients and sharp curves, so that a high, safe speed might be maintained. The steepest gradient does not exceed 3 per cent., the sharpest curve being 18°. The track rails weigh 95 lbs. per yd., laid on 8-ft. ties, spaced to 24-in. centres. 9-ft. ties are used for every fifth tie, where insulators are fixed to support the third rail. A notable feature in connection with the third rail is that it is hooded or protected from sleet and snow by a pine plank 6 in. + 2 in. fixed directly over the rail. The usefulness of this has already been demonstrated during severe snowstorms, and the added element of personal safety is also very great. The guard plank is supported by oak posts, spaced 8 ft. apart, and both guard and rail are carried by unglazed vitrified clay insulators spaced every 10 ft. apart. The contact rails are in 60-ft. lengths, and weigh 80 lbs. per yd. Both these and the track rails are bonded with soldered bonds which have proved satisfactory. The Sprague multiple unit control system is used on the cars. Sectional drawings of the third rail, with hood and shoe, are given. The power-house and substation electrical equipment is of standard Westinghouse make throughout. A portable substation mounted on a truck, which can be hauled to any part of the system, forms part of the equipment. This is for use in places where the demands are unusually heavy, owing to special circumstances, such as occur during the excursion and picnic season. F. B.

932. *Electrical Safety Apparatus for Trains in Motion.* (Canad. Elect. News, 13. p. 37, March, 1903.)—A light third rail is fixed between the running rails and is in electrical connection with the signal-box controlling the section. On the locomotive a telephone, an alarm, and a red lamp are fitted, by means of which warning can be given to the driver, who can then speak to the signalman. A section of a German railway is being fitted up as the result of experiments carried out on the main line between Frankfort and Hanau. F. B.

933. *Ganz System of Canal Haulage.* **G. Szasz.** (Feilden, 8. pp. 186–196, March, 1903.)—The author describes the system put forward by Ganz in the competition which took place in connection with the Teltow Canal scheme. In principle it is a monorail system. The locomotive has two inclined pairs of axles; on every axle there is an inclined wheel, and each pair of wheel embraces the rail-head. There is in addition another wheel beneath the locomotive, running on the towpath at one side of the rail; this wheel is to prevent any tendency to topple over, but the design is such that the weight of the locomotive falls on the inclined wheels. The advantages of this system are said to be that a very high coefficient of adhesion is obtained, the adhesion

Digitized by Google

amounting to 186 per cent. of the weight in the Teltow scheme; and that the tow-rope pull can be utilised to increase the adhesion still further with an increased output, the stability of the locomotive being increased accordingly. The proposed system of construction is illustrated by drawings, and the method is said to be much cheaper than other proposed schemes for the Teltow Canal, both in first cost and in the matter of working expenses. W. H. S.

934. *Taeggi-Piscicelli Postal System.* **R. Salvadori.** (Atti dell' Assoc. Elettr. Ital. 7. pp. 63–72, Feb., 1903.)—The author considers this system to be entirely unpractical. He shows that the adhesion of the wheels would be insufficient to overcome air resistance at the speed of 400 km. per hour which it is proposed to attain; that the motors would have to be of 55 h.p. each, instead of 1 h.p.; that the downward force due to the 50 kg. car, when moving over a catenary with only 0·5 m. dip, at the speed named would be 2,500 kg. [See also Abstract No. 220 (1903).] A. E. L.

ELECTRIC LAMPS AND LIGHTING.

935. *New Standard Light.* **J. E. Petavel.** (Electrician, 50. pp. 1012–1015, April 10, 1903.)—The author studies incandescent standards. The substance used must be capable of withstanding a temperature of 1600° C. without fusion or oxidation, and its coefficient of emissivity must remain unaltered. Moreover, it should preferably be an electric conductor, as this is more conveniently heated. The choice is therefore limited to platinum, rhodium, iridium, and their alloys. Temperatures above the melting-point of platinum must be estimated by formulæ. The results of these calculations lead us to suppose that the melting point of platinum-iridium, containing 25 per cent. of iridium, is between 1,868° and 1,888° C., while the melting-point of iridium is about 2,423° C. The formulæ proposed are $t = 400 + 889{\cdot}6\sqrt[6{\cdot}9]{b}$, where t is the temperature and b the intrinsic brilliancy in c.p. per sq. cm., and $t = 872 + 81{\cdot}63h$, where t is the temperature and h the percentage of total radiation passing through a 2 cm. water-trough having quartz sides. The intrinsic brilliancy of iridium near its melting-point is about 15 times as great as that of platinum near its melting-point. But at this temperature iridium foil gradually disintegrates. Temperatures are best experimentally determined by the fact that the wave-length at which the maximum radiation occurs is inversely proportional to the absolute temperature, and this is indirectly determined by observing the relative intensity of the radiation at two different wave-lengths at opposite ends of the spectrum. It is necessary first to study the absorption by various bodies, the results being given in several curves, which include figures for glass, quartz, fluorspar, water, benzol, and carbon bisulphide. In the author's experiments the incandescent metal strip sends three separate beams through openings in a water screen. The central beam falls on a photometer; the other beams fall respectively on glass and black fluorspar, and then on thermopiles, which are connected in opposition through a galvanometer. There is a critical temperature at which the galvanometer deflection is zero, and this depends on the relative thickness of the plates and the distances of the thermopiles. A photograph of the apparatus is given, and also a diagrammatic representation of the same. [See also Abstract No. 718 (1903).] W. H. S.

Digitized by Google

936. *Economy in Electric Lighting.* **K. Zipernowsky.** (Zeitschr. Elektrotechn., Wien. 21. pp. 61–66; Discussion, pp. 66–67, Feb. 1, 1903. Paper read before the Elektrotechnische Verein at Vienna, Dec. 10, 1902.)—Although great efforts have been made to improve the efficiencies of dynamos, &c., the incandescent lamp remains as it was, having an efficiency of between 5 and 7 per cent. The author refers to Feldmann's work on this subject in 1892, which still is substantially applicable to existing lamps. Feldmann divided lamps into three classes, viz., those beginning their life with an efficiency of 1·72, 2·76, and 8·32 watts per c.p. (Hefner). The author examines these three classes, and gives an expression which represents the cost in each case of a c.p.-hour, the cost of the lamp itself being included, and a variable introduced which represents the total life of the lamp. By differentiating, the most economical life of the lamp is ascertained. Assuming a lamp to cost 60 hellers, and the Board of Trade Unit 70 hellers, the most economical lives of the three groups are 100, 160, and 309 hours respectively, and the costs of the c.p.-hour are 0·20, 0·243, and 0·258 hellers. From this it appears that lamps taking 1·7 watts per Hefner c.p. are the most economical, if they can be relied upon to last 100 hours. Stark has shown that the blackening of the bulb depends greatly on the temperature of the filament, and partly on the difference of voltage between the extremities of the filament. If, therefore, lamps of lower voltage were used, the blackening would be much diminished. The author therefore advocates the system of Blondel, Weissmann, and Wydts, in which 20-volt lamps are used on 100-volt networks, the pressure being reduced by house transformers. If any considerable economies are to be effected, it is necessary to devise lamps the efficiency curves of which shall be different from those of the lamps now generally in use. That this is possible is shown by the fact that lamps have been made and examined, the candle powers of which increased at first and only recovered their initial values after periods as great as 400 hours. On the Weissmann system, assuming a loss of 5 per cent. in the transformer, with a 15-c.p. lamp costing 80 hellers, and an economical life of 400 hours, a c.p.-hour would cost 0·138 heller. Comparing this with the Osmium lamp with a life of 1,000 hours, it would appear that the Osmium lamp might possibly be 5 per cent. cheaper than lamps burnt on the Weissmann system. In the discussion, various speakers emphasised the economies to be derived from the Blondel-Weissmann system. W. H. S.

937. *Train Lighting by Electricity.* **A. J. Farnsworth.** (Amer. Inst. Elect. Engin., Trans. 20. pp. 339–348; Discussion, pp. 355–376, March, 1903.)—It is here proposed to drive a generator from the axle of the car, and to keep the voltage constant by an automatic device which varies the resistance in the field circuit of the dynamo. The regulating apparatus is mounted on a board, which contains a solenoid with a spring-balanced plunger, the field rheostat, a ratchet mechanism operated by a small motor, and other subsidiary devices. An increase of train speed causes the pull of the solenoid to overcome the spring, and thus to set the ratchet mechanism in operation whereby the arm of the field rheostat is moved over one or more points till a position of equilibrium is reached. Details of the ratchet mechanism, and a diagrammatic sketch of the connections are given. A small battery of accumulators is also provided in the usual way; during the time the battery is being charged, the regulator throws into circuit a variable resistance in series with the lamps, in order to reduce the applied voltage. The regulator is adjusted in each case for the average run of the car, and must be deter-

Digitized by Google

mined by the number of ampere-hours required per day for lighting the train by the train speed, &c. W. H. S.

938. *Train Lighting by Electricity.* **C. Jacquin.** (Écl. Électr. 35. pp. 81–95, April 18, 1903.)—The author describes a system in use on some of the northern Prussian lines. It embodies the invention of Büttner, and is carried out by the Allgemeine Elektrizitäts Gesellschaft. The main idea is borrowed from the Nernst lamp, which has in series with it an iron resistance mounted in a glass bulb filled with hydrogen, serving to regulate the voltage applied at the terminals of the lamp. The Büttner system arranges similar resistances in series with the incandescent lamps on the trains, and these resistances have the effect of choking off any slight increase of voltage. Each carriage has a small battery placed beneath it, and the dynamo is mounted on the engine and driven by a de Laval turbine. While the engine is attached to the train, current is supplied by the dynamo; at other times the battery is used. The dynamo and turbine are placed outside the engine boiler between the safety valve and the steam dome. [See also Abstract No. 574 (1903).] W. H. S.

939. *Train Lighting by Electricity.* **W. L. Bliss.** (Amer. Inst. Elect. Engin., Trans. 20. pp. 309–330; Discussion, pp. 355–376, March, 1903.)—The author describes his system, in which the dynamo is driven from the axle by means of single reduction gearing. It is impossible to machine the axle in any way, as this is not allowed by the railway authorities; and as axles are always rough, and the use of keys, set screws, &c., is impracticable, the gearing is mounted on a hollow shaft, constructed in two halves, driven from the axle by a flexible connection. This connection consists of a two-armed dog clamped to the axle, and attached by four springs to the two arms of the hollow shaft, the attachment being made by ball-and-socket fastenings. The generator is of the iron-clad four-pole type, and its weight is carried by the truck frame. The brushes are carried by a holder, mounted on a carrier which is supported on anti-friction bearings. The friction between the brushes and the commutator causes the holder to be rotated in the direction of rotation of the armature until its movement is arrested by a stop. In this way the position of the brushes is reversed with the direction of rotation, and the direction of the current is kept constant. The methods of regulation are described. The main feature is a dynamotor mounted on the bottom of the car, and driven by the main dynamo: the dynamotor generates a counter e.m.f. in the field circuit of the main generator, and as this e.m.f. increases with the speed, the excitation is decreased correspondingly. W. H. S.

940. *Electric Lighting of Trains.* **G. D. Shephardson.** (Amer. Inst. Elect. Engin., Trans. 20. pp. 349–354; Discussion, pp. 355–376, March, 1903.) —A general survey of the experience of the last ten years in connection with the lighting of trains by electricity, including the advantages and disadvantages of batteries, axle systems of driving, and the provision of a special engine for driving purposes. W. H. S.

REFERENCES.

941. *Hallan Electricity Works.* **F. C. Perkins.** (Elect. Rev. N.Y. 42. pp. 544–545, April 18, 1903.)—A small single-phase alternating-current light and power distribution system. A. H. A.

Digitized by Google

942. *Valtelina Railway.* **D. Korda.** (Soc. Int. Élect., Bull. 3. pp. 96–137, March, 1903.)—A detailed description of the Ganz high-tension, three-phase railway. The official tests show that the consumption of energy, measured at the generating station, is 41·5 watt-hours per ton-km., costing 9 centimes, as compared with 23·5 centimes, the cost of coal for steam traction. The repairs to the electric motor cars and locomotives cost 3 centimes per km., that of the steam locomotives 9 centimes. [See also Abstract No. 430 (1903).] A. E. L.

943. *Berlin Tramways.* (Elektrotechn. Zeitschr. 24. pp. 79–85, Jan. 29, 1903.)—This article describes some of the details of construction of those tramway lines, mostly in connection with the overhead work. [See also Abstract No. 560 (1903).] W. H. S.

944. *Electrical Haulage on Canals.* **E. W. Marchant.** (Electrician, 50. pp. 423–425, Jan. 2, and pp. 511–513; Discussion, pp. 513–514, Jan. 16, 1903. Paper read before the Manchester Section of the Institution of Electrical Engineers, Dec. 16, 1902.)—The author describes the work which has been done by Gérard on the Charleroi canal, and by Köttgen and Siemens and Halske on the Finow and Teltow canals. [See also Abstract No. 60 (1903).] W. H. S.

945. *Ilford Electric Tramways.* (Elect. Engin. 31. pp. 402–405, March 20, 1903.)—A brief general description. The article contains a drawing showing the switch-board connections, and another showing the special work at a complicated crossing. W. H. S.

946. *Brussels Conduit Tramways.* (Soc. Belge Élect., Bull. 19. pp. 545–560, Sept., 1902.)—The tramways here described constitute the latest addition to those already existing and are on the same general lines. Drawings are given showing the construction of the conduit in plan and cross-section, and also of the crossing-points. W. H. S.

947. *Arc-lighting in Westminster.* (Electrician, 50. pp. 1065–1067, April 17, 1903.)—This article gives a summary of a report by the Westminster surveyor on the amount of light that is given by the various systems that are used for local illumination. Figures are also given showing the conditions under which the contracts for arc lighting have been undertaken by the various companies. W. H. S.

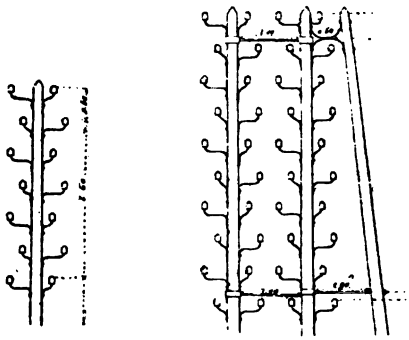
948. *Train-lighting by Electricity.* **E. A. Sperry.** (Amer. Inst. Elect. Engin., Trans. 20. pp. 331–338; Discussion, pp. 355–376, March, 1903.)—The paper contains some general remarks about train-lighting, and states that the author is intending to introduce a system by which the speed of the generator is kept constant, but no details are given. W. H. S.

949. *Train-lighting Systems.* (Zeitschr. Elektrotechn., Wien, 20. pp. 610–611, Dec. 7, 1902.)—A detailed description of the Kull system [see Abstract No. 382 (1903)] and of the Böhm system, in which a dynamo is driven from the axle by friction gear thrown out when the speed is low, the lighting being then supplied by accumulators. Exact details of this system are not given. A. E. L.

Digitized by Google

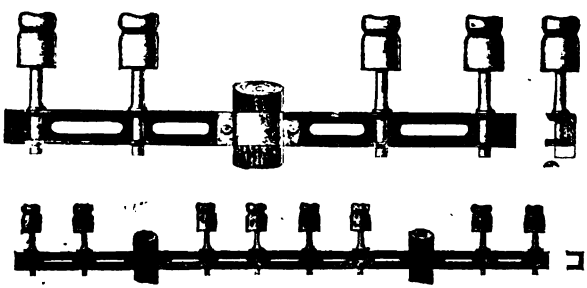
TELEGRAPHY AND TELEPHONY.

950. *Telegraph and Telephone Posts and Brackets.* **J. A. Montpellier.**



FRENCH.

(Electricien, 25. pp. 244–248, April 18, 1903.)—Describes the methods of France and Germany. The distinctions are shown in the diagrams. The French



GERMAN.

administration also uses horizontal arms carrying six insulators supported on two posts. E. O. W.

951. *Murray Printing Telegraph.* (Elect. Rev. 52. pp. 459–460, March 13; 503–504, March 20; 545–546, March 27; and pp. 591–592, April 3, 1903.)—*The Alphabet.*—The tape, perforated in the centre, is marked off in half inches, a character occupying that space. Characters are formed of one or more impulses up to five. The following is a specimen of the alphabet.

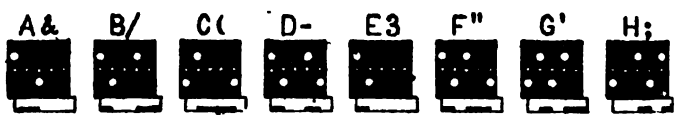


FIG. 1.

The broken lines below denote the length of the marking current. *The Perforator.*—The keys act on steel bars, which again operate bell crank

Digitized by Google

levers, whose striking bars, actuated by an electro-magnet, work the punches. The latter are retracted by springs. The tape is fed by a star wheel whose shaft is driven by a shunt-wound motor. The shaft is controlled by an escapement, acted on by a spacing electro-magnet. *Transmitting vibrator.*—An iron reed vibrates between two adjustable contacts, and is actuated by two pairs of electro-magnets, the circuits of which are alternately opened and closed at these contacts. The speed of the vibration is regulated by movable weights. The vibrator alternately energises two electromagnets, which drive a wheel. *The transmitter.*—This is a modification of the ordinary Wheatstone,

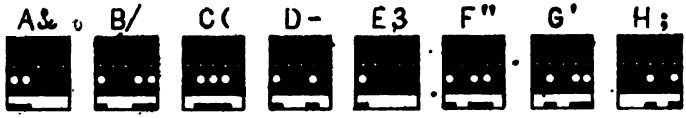


FIG. 2.

and is constructed so that the vertical needles or prickers which are in line with the advancing lines of perforations in the tape move together, thereby enabling any desired multiple of a single impulse to be sent to line. *The receiver.*—The arriving signals operate a post-office relay, which controls the local relays, which latter bring into play the punch on the receiving tape. One of the local relays is for punching and one for governing. *The recorder.*—This consists of a shunt-wound motor, a tape-stopping relay, and the mechanism for perforating the received slip. In the latter two electro-magnets are concerned, the punching and the spacing. The armature of the former, through a rigid arm, brings down the punch, the arm having a

RECEIVING ARRANGEMENTS.

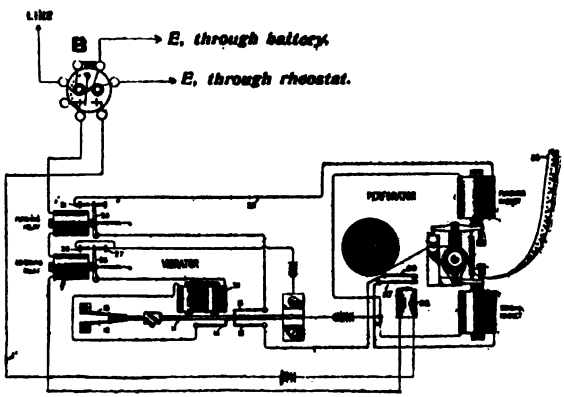


FIG. 3.

spring which retracts the punch after each perforation. The armature of the spacing magnet carries an anchor escapement for checking the movement of the spindle of the sprocket feed-wheel. The manner in which the characters are received is shown in Fig. 2. The spindle of the feed wheel and the shaft of the driving motor are connected by a species of friction clutch, the friction being sufficient to wind up a spring in a drum which sharply actuates the sprocket wheel when the escapement releases it. A speed of 150 words per minute has been obtained. *Receiving vibrator.*—The iron reed in this instrument is the means of maintaining unison. Movable

Digitized by Google

weights regulate the rate of vibration. The resilient springs 13 and 12 cushion the impact and impart initial return motion, and are important features. Adjustment is so contrived that the break point of the governing relay at 26 and that of the vibrator at 14 open and close together. There is found to exist a steady dynamic balance between the accelerating tendency of the reed and the retarding tendency of the arriving signals. In practice the receiving vibrator is set to go 1 to 2 per cent. faster than the arriving signals. *The printer.*—The received perforated tape is inserted in an automatic type-writing device, in which five points are presented to a perforated plate or die. These points register with five holes in the plate. The points being connected with reciprocating bars, and thin metal strips lying across the bars, the notches on the bars cause the strips to move the typewriter levers, through the agency of motor-driven cams. The maximum speed of the printer is about 120 words per minute. [See also Abstract No. 1013 (1901).] E. O. W.

952. *Resistance and Capacity in Long Submarine Cables.* **J. E. Young.** (Electrician, 50. pp. 813–816, March 6; and pp. 847–848, March 13, 1903.)—Comparisons of signals on submarine cables having different ratios of resistance R, to capacity S, are misleading unless the e.m.f.'s, terminal resistances, and capacities are adjusted to the ratio R/S of the line. The quantity $\sqrt{R/Sp}$ (where p is the coefficient involving the shape of the wave), by which the instantaneous volts must be divided to find the instantaneous amperes, determines: (1) e.m.f. of battery; (2) curbing (sending or receiving end); (3) maximum and mean pressures on cable; (4) best resistance of battery for given maximum pressure; (5) best resistance and inductance of receiver; (6) duplex adjustments. With battery impulses made through a condenser, p goes up with the speed; with automatic curb direct transmission, the shape of the impulse, and value of p, is more nearly the same at all speeds. At 100 letters per min., $p = 40$. At 150 letters per min., it will be 60, and at 200 letters per min. $p = 80$. The usual figure for the maximum speed given by the S.R. law is 600/SR letters per min. for "long" cables. For direct sending, the author deduces that the lower the CR (conductor resistance) per microfarad of the core, the shorter the contacts required to produce signals of a given size, and that the e.m.f. necessary to generate signals of a given size is directly proportional to the square root of the CR per microfarad of the core. *For Condenser Sending:* To get a given size of signal with constant curbing the e.m.f. must be raised as the square root of the CR per microfarad after adjustment of the condensers. Where curbing is done by reverse currents, the lower the CR per microfarad, the shorter is the correct duration of curbing contact relatively to the main one required for straightness of signals. F. A. Taylor and H. K. C. Fisher observed the ordinates of the pressure wave during the first tenth of a second's battery contact, and found that:—(*a*) Increasing battery resistance reduces the maximum stress; (*b*) increasing condenser capacity augments maximum stress; (*c*) increasing CR per microfarad augments maximum stress; (*d*) increasing the ratio of CR per microfarad to resistance of battery augments maximum stress. Observation shows that the mean or effective pressure on the cable is kept constant when the capacity of the sending condenser is made inversely as the square root of the CR per microfarad, and it would appear that the maximum pressure on the cable is kept constant by making the capacity, the sending condenser, vary inversely as $\sqrt{R/S}$ of the core, with

Digitized by Google

constant e.m.f. and negligible battery resistance. Taylor and Fisher showed that, by reason of its influence, and the form of wave through a condenser, battery resistance may be beneficial in keeping down the peak in the pressure waves, so that e.m.f. can be raised without exceeding a given maximum stress, whilst in automatic curb transmission direct to line, the lower the battery resistance the better. With condensing curb sending it has a certain "best value." This best value of the battery resistance in condenser sending is the limit to which its resistance can be raised conjointly with e.m.f. without exceeding a given maximum stress beyond which limit the gain in amplitude of the wave is neutralised by the loss of sharpness of form. The best resistance of the receiver, in direct working, varies directly as the square root of the CR per microfarad of the line, for a given signalling speed, and, according to Hockin, it also varies inversely as the square root of the speed of sending, when CR per microfarad is constant. For condenser working the author finds that: (*a*) The higher the CR per microfarad, the greater the best resistance of receiver; (*b*) the higher the speed of sending, the less the best resistance of receiver; (*c*) The higher the condenser capacity, the less the best resistance of the receiver. In all cases it is to be noticed that the best resistance is independent of the total SR of the line. In the condenser bridge or "double-block" duplex system, it is conclusively proved that a working balance or effective equality between the pair of pressure waves is only produced when the bridge condensers are adjusted inversely as the square roots of the CR's per microfarad of the cable and artificial line respectively. M. O'G.

953. *Telephone Lines.* **G. A. Campbell.** (Phil. Mag. 5. pp. 313-330, March, 1903.)—The case considered is an electrical circuit consisting of two long parallel wires having self-induction coils inserted at regular intervals. The mathematical treatment relates to the forced harmonic state, for a range of frequency corresponding to telephonic transmission. Starting with the usual expressions for the attenuation-coefficient, velocity, and line impedance, the author seeks to determine the correction factors for a loaded line, making use of C. Godfrey's results. [See Abstract No. 905 (1898).] By assuming that there is no leakage and no line induction, and that a third quantity, depending upon the line and the load, is small, the required coefficients are obtained and are discussed by the aid of curves. It is shown that by introducing transformers into a line at every point of non-uniformity due to apparatus or a change in line construction, reflection losses may be eliminated, and the effective attenuation made as small as, or smaller than, the real line attenuation. With no inductance the attenuation curve is a parabola. Any increase in inductance reduces the attenuation and makes it more nearly uniform; and, by a sufficient increase in the inductance, the attenuation can be reduced to any desired value, provided that there is no leakage. Upon an infinite line of periodic recurrent structure, a steady, forced harmonic disturbance falls off exponentially from one periodic interval to the next. In cable circuits the inductance, according to the author, is quite negligible; and a moderately loaded open wire circuit would have several times more load than line inductance. The first essential condition for an efficiently loaded line is that there must be more than two coils per wave-length, or, approximately, π coils per wave-length with the load uniformly distributed. The harmonics can all be cut down as far as desired by the use of a sufficient number of sections, while the attenuation of the fundamental can be reduced by decreasing the resistance. The line does not require tuning; and provided that the ratio of the

Digitized by Google

resistance of the loading coil to the resistance of the line is small, the action is, for a considerable range of frequency, quite independent of frequency. By combining condensers and inductances, a system can be made which cuts out not only higher frequencies, but also all frequencies below a certain limit.

The author calculates the loading for maximum efficiency, for a given weight of copper in line and in load. This problem reduces to securing minimum attenuation at the frequency of transmission. The result arrived at is that, for a given total weight of copper in line and load, the attenuation at a given frequency is made a minimum by placing $\frac{4}{7}$ of the copper in coils having a resistance equal to $\frac{3}{7}$ of the line resistance, and spacing them 4·8 per uniform line wave-length, *i.e.*, $\pi/\sin^{-1}\sqrt{\frac{3}{7}} = 4{\cdot}401$ per actual wave-length on the loaded line. R. A.

954. *Disturbances on Telephone Lines.* **P. M. Lincoln.** (Amer. Inst. Elect. Engin., Trans. 20. pp. 427–433 ; Discussion, pp. 445–498, and 521–584, April, 1903.)—Disturbances on lines which run parallel to high-tension transmission lines are specially considered. These are principally due to electromagnetic or electrostatic induction, though leakage also plays a part in causing disturbance. By transposing the telephone wires at intervals, or by transposing the power wires similarly, the effects of both kinds of induction can be neutralised. A series telephone should not be used on a circuit in which static induction takes place to any great extent, and the bridged telephone is to be preferred under these circumstances. If the insulation of the power lines is faulty at any point, the effects of electrostatic induction on the telephone lines will be to cause the telephone lines to assume a potential which differs from that of earth. The neutral point on the power line is shifted to an extent which depends on the resistance of the leak, and this reacts on the telephone line accordingly. The amount of the electrostatic potential between the telephone circuit and earth will depend upon the relative capacities between the power and telephone lines on the one hand, and between telephone line and earth on the other. Usually the latter capacity is not less than the former, in which case the potential of the telephone wires above earth will be at least one-half the potential of the power line neutral point above earth. Consequently in the majority of cases telephones cease to operate when a ground occurs on the power lines. A thoroughly good insulation for the telephone line is therefore absolutely necessary both outside and inside the buildings. The induced voltage is not, however, so dangerous to users as its amount might lead one to suppose ; the current is limited to that of a condenser, consisting of power line as one plate and telephone line as the other. Considered as condensers, the capacity of the telephone wires to earth should be made as great as possible, and of telephone wires to power wires as small as possible. This may be accomplished by increasing the distance between power and telephone lines, and if both are carried on the same structure, the effect may be increased by running one or two ground wires in close proximity to the telephone wires. W. H. S.

REFERENCE.

955. *Modified Keyboard for Hughes' Type-printer.* **P. Genuardi.** (Elettricista, Rome, 12. pp. 96–98, April, 1903.)—By arranging the numerals in consecutive order with intervals of two keys from one to the next, the author claims that the number of combinations of figures which can be signalled in one revolution of the type-wheel can be increased. A. E. L.

Digitized by Google

Dec. 24, 1903.] Entered as second-class matter at the New York, N.Y., Post Office, February 23, 1900. [No. 72.

SCIENCE ABSTRACTS

SECTION B.—ELECTRICAL ENGINEERING

VOL. 6. Published Monthly. PART 12.

Issued by the

INSTITUTION OF ELECTRICAL ENGINEERS,

92, VICTORIA STREET, LONDON, S.W.;

With the Co-operation of

THE PHYSICAL SOCIETY OF LONDON,

THE AMERICAN PHYSICAL SOCIETY,

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, and

THE AMERICAN ELECTRO-CHEMICAL SOCIETY.

EDITOR.

G. W. de TUNZELMANN, B.Sc. M.I.E.E.

ABSTRACTORS.

G. E. ALLAN, B.Sc.
A. H. ALLEN.
C. EDGAR ALLEN.
R. APPLEYARD, A.M.Inst.C.E.
L. B. ATKINSON.
K. C. C. BALY, F.I.C.
E. H. BARTON, D.Sc., F.R.S.E.
R. E. BAYNES, M.A.
FR. BEER, Ph.D.
H. BORNS, Ph.D.
F. BROADBENT, M.I.E.E.
H. BURBURY, M.A., F.R.S.
C. P. BUTLER, A.R.C.Sc., F.R.P.S.
C. CAPITO, M.I.E.E.
L. D. COALES, B.Sc.
W. R. COOPER, B.Sc., A.I.C.
S. H. COZENS-HARDY.
W. J. CRAMOND.
E. G. CRUISE.
H. R. CULLEN, M.A.
A. DANIELL, M.A.
PHILIP DAWSON, M.I.E.E.
C. R. D'ESTERRE.
W. P. DIGBY, A.M.I.M.E.
F. G. DONNAN, M.A., Ph.D.
J. ERSKINE-MURRAY, D.Sc.
MISS A. EVERETT, M.A.
C. K. FALKENSTEIN, Jr.
A. FANTI.
A. FINDLAY, M.A., Ph.D.
L. GASTER.
PROF. W. W. HALDANE GEE.
G. GLASER, Ph.D.
A. GRADENWITZ, Ph.D.
J. GRAY, B.Sc.
PROF. A. HAY, D.Sc.
A. C. HEAP.
J. B. HENDERSON, D.Sc.
W. C. HENDERSON, M.A., D.Sc.
H. M. HOBART.
H. F. HUNT, B.Sc.
D. H. JACKSON, M.A., Ph.D.
PROF. D. E. JONES, B.Sc.
H. LEWIS JONES, M.D.
J. B. C. KERSHAW, F.I.C.
J. E. KINGSBURY, M.I.E.E.
A. E. LEVIN.
T. M. LOWRY, D.Sc.
W. G. McMILLAN, F.I.C.
D. K. MORRIS, Ph.D.
M. O'GORMAN, M.I.E.E.
J. W. PECK, M.A.
T. H. POPE.
T. S. PRICE, D.Sc., Ph.D.
W. G. RHODES, D.Sc.
S. RIDEAL, D.Sc., F.I.C.
J. H. RIDER.
E. C. RIMINGTON.
R. C. ROBERTS.
L. S. ROBERTSON, M.Inst.C.E.
PROF. W. ROBINSON, M.E.
E. S. A. ROBSON, M.Sc.
F. ROGERS, B.Sc.
R. B. ROGERS, M.A.
J. T. ROSSITER, M.I.M.E.
F. J. ROWAN, A.M.Inst.C.E.
A. RUSSELL, M.A.
B. F. SCATTERGOOD, M.A.
E. K. SCOTT.
P. E. SHAW, B.A., D.Sc.
F. SHEDDEN, B.Sc., F.I.C.
S. G. STARLING, B.Sc., A.R.C.S.
O. J. STEINHART, Ph.D.
J. J. STEWART, M.A., B.Sc.
W. STEWART, M.A., D.Sc.
W. H. STORY, M.A.
R. THRELFALL, M.A., F.R.S.
G. W. de TUNZELMANN, B.Sc.
J. L. F. VOGEL.
B. J. WADE.
E. O. WALKER, C.I.E., M.I.E.E.
L. H. WALTER, M.A., A.M.I.C.E.
W. E. WARRILOW.
R. S. WILLOWS, B.A., D.Sc.
H. W. F. YOUNG, B.A., M.D.

Price, post free, Single Numbers, 1s. 6d., or 40 cents net.

Annual Subscription, 18s., or $4.50 net, including the Yearly Index.

Annual Subscription for both Sections, 30s., or $7.50 net.

LONDON:

E. & F. N. SPON, LIMITED, 125, STRAND, W.C.

NEW YORK:

SPON & CHAMBERLAIN, 123, LIBERTY STREET.

Digitized by Google

British Insulated & Helsby Cables

LIMITED.

WORKS PRESCOT, HELSBY & LIVERPOOL.

ELECTRICAL CABLE MAKERS

Paper, Rubber, Gutta Percha,
Insulated & Lead-Covered,
Flexible Cords,
Cotton-Covered Wire,
&c., &c.

CONTRACTORS

FOR THE

Complete Equipment of

TRAMWAY, POWER TRANSMISSION,
LIGHTING,
TELEGRAPH & TELEPHONE SYSTEMS.

MANUFACTURERS OF . .

Junction Boxes, Section Pillars, Overhead Tramway Gear, Bonds, Switchboards, Telephone Exchange Equipments, Batteries, Insulators, Meters, Fire Alarm and Police Equipments, Railway Signals and Blocks, Mining Exploders and Shot Firing Cable, &c., &c.

HIGH CONDUCTIVITY COPPER

Rolled or Drawn to any Wire Gauge, Section, or Specification.

Digitized by Google

SCIENCE ABSTRACTS.

Section B.—ENGINEERING.

DECEMBER 1903.

STEAM PLANT, GAS AND OIL ENGINES.

STEAM PLANT.

956. *High-Speed Electrical Generating Plant.* **T. H. Minshall.** (Inst. Civil Engin., Proc. 151. pp. 6–67; Discussion, pp. 68–110, Dec. 2, 1902.)—After some historical notes and remarks on the general conditions of high-speed running, the author refers to the steady advance being made in the construction of dynamos suitable for high-speed running. Conditions of governing are discussed, and data are given showing that at light loads the efficiency of high-speed engines is relatively high, though lower at full load than low-speed ones. The former are therefore specially suitable in the case of variable loads. The attainment of the maximum efficiency theoretically possible is prevented by the increased clearance and leakage, and the comparatively unsatisfactory steam distribution resulting from the necessity of using piston valves. The cylinder vacuum is also lower, owing to the necessity of cushioning. The loss from the greater clearance is diminished by the cut-off being later than in low-speed engines. The economy of superheating is greater with high-speed engines, owing, in part, to the reduced leakage. High superheat should, however, not be employed until the cylinders have been worn to a good surface. The initial efficiency of these engines is often rather low, and hence the initial losses are often found to diminish to the extent of as much as 20 per cent. after a few months' working. When the speed exceeds 200 to 230 r.p.m., the air pumps should be run at a slower speed, for continuous work, and the consequent distance between the engine and condenser plant reduces the advantages derived from condensation. Throttle governing is satisfactory for steady loads, and, even in the case of traction overloads, the economy of expansion governing is much less than is generally supposed. With pressures of 160 lbs. per sq. in. and over, the economy of triple expansion is greater than in the case of low-speed engines, and is unaccompanied by any increase in difficulty of governing. The question of capital outlay on a power-station is in favour of high-speed engines. Where alternators are used, their increased efficiency and lower cost at high speeds are additional arguments in favour of the use of high-speed engines. Special attention was drawn to the safety of the flywheel in high-speed engines. The paper is accompanied by a large number of illustrative curves and tables giving the

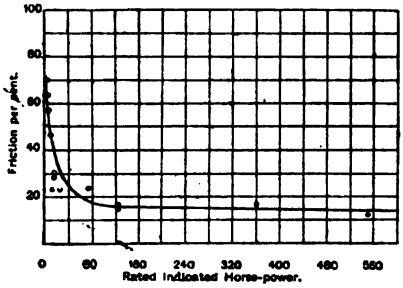
Digitized by Google

results of engine tests, comparative costs, wear, and other details. [The high-speed engine data given in the paper mainly refer to Bellis and Morcom engines.] The paper was discussed at considerable length, some speakers traversing, and others supporting, the author's conclusions. G. W. DE T.

957. *Choice of Steam Boilers.* **C. E. Stromeyer.** (Engineer, 95. p. 555, May 29, 1903. Paper read before the Civil and Mechanical Engineers' Society, May 7, 1903.)—In this paper the author deals with constructive details of boilers of the Lancashire and marine return-tube types, which he selects as the most efficient and durable in general use. Water-tube boilers are objected to because they are unsuitable for work with sedimentary waters. He maintains that the former can raise steam as rapidly as the latter, provided the former are equipped with apparatus for artificial circulation of the water. Regarding radiation and heat carried up the chimney, the two important sources of heat losses from boilers, he endeavours to show that loss from radiation is greater from water-tube boilers on account of the larger amount of heating surface and the brickwork in furnaces. He prefers to minimise the heat losses by waste gases by using economisers with Lancashire boilers, rather than the additional heating surface of water-tube boilers, although he admits that these latter occupy less floor space than boilers of the former type. [See also Abstracts Nos. 151 (1902) and 607 (1903).] F. J. R.

GAS AND OIL ENGINES.

958. *Friction in Gas Engines.* **H. E. Thompson.** (Mech. Eng. 11. pp. 786–788, May 30, 1903. Reproduced from the Proceedings of the Society of Mechanical Engineers of Cornell University.)—The formulæ given by Rankine and others for steam-engine friction assume an increase of friction with the load, the speed remaining constant. According, however, to recent experiments, this friction is sensibly constant for ordinary working conditions and range of power. C. H. Robertson



states in his report on the Westinghouse gas engine that there is a very slight increase of friction with increase of load, and expresses the power lost in friction by the formula F.H.P. $= (F.H.P.)_0 + c$ (B.H.P.), where $(F.H.P.)_0$ is the zero brake-load, and c is a constant equal to 0·017. It is common practice with steam engines to regard the work as indicated by the diagram of an engine running light as equal to the frictional loss. But with a gas engine there is some objection to this. The author contends that a gas engine running light, whether of the throttling or "hit-and-miss" type, has its valve inlet closed by the governor for a considerable part of the

Digitized by Google

time, and the outgoing piston, during the firing stroke, does work against the suction that is never present when the engine is loaded. This suction is not overbalanced by opposite work being done on the return stroke, for then the exhaust-valves are always open. This feature occurs in nearly all gas engines of either the throttling, or the "hit-and-miss," type of regulation. Data obtained from tests of a number of gas engines of various types have led the author to the following conclusions: (1) The friction of the gas engine is nearly, and for all practical purposes is, constant for all variations of load within the ordinary range of any engine, and for uniform speed and lubrication. (2) The friction increases with the speed of rotation and the inefficiency of lubrication. (3) What slight increase of friction there may be with the load seems to follow a rule similar to Robertson's formula, $F.H.P. = (F.H.P.)_0 + c\,(B.H.P.)$, but with a small value for the constant, c. This slight increase in friction loss is due to both increased pressure and load on the journals, and to a higher admission pressure in the cylinder, due to a richer mixture of combustible having been admitted by the governing mechanism in response to the increased load on the engine. (4) The average ratio of frictional h.p. to rated i.h.p. varies in different gas engines from 10 to 50 per cent., with an average of 20 to 30 per cent. of rated i.h.p. The accompanying curve shows how the percentage of friction h.p. varies with the i.h.p. in several cases. These percentages are taken from the mean value of the friction h.p. at the point of rated indicated load, each case thereby furnishing but one value for the curve. It is seen, as stated before, how the percentage of friction loss decreases with the larger-sized engines, but increases with the smaller engines. A curve for each engine would probably be similar to this one, but showing how the percentage of friction varies as the load increases, although the friction h.p. itself may remain nearly constant. The data of this curve are :—

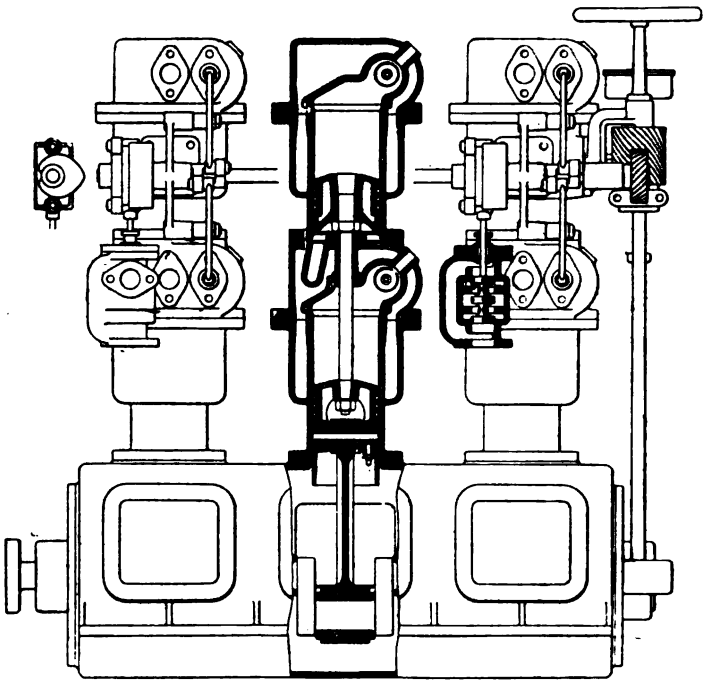
Name.	Rated I.H.P.	F.H.P.	Friction per. cent.
Westinghouse	125	19	14·4
Westinghouse	125	20·5	16·4
Westinghouse	550	67	12·2
Springfield	6	3·8	63·4
Springfield	6	3·42	57
Lazier	25	5·75	23
Acme	16	4·9	30·6
Acme	16	4·6	28·8
Walrath	75	16	24
Westinghouse	10	4·6	46
Priestman	12	2·8	23·4
Crossley	400	68	17

G. W. DE T.

959. *Dunlop Gas Engine.* (Mech. Eng. 11. pp. 616–619, May 9, 1908.)—This is a single-acting engine, operating on the four-stroke compression cycle, of simple design, self-starting and reversing, and giving a turning moment equal to that of a steam engine. Sectional drawings are given of a three-crank, vertical, tandem launch engine, in which the necessity for a flywheel is obviated by a construction which causes the explosions to take place in a continuous overlapping series. The admission and exhaust valves are

Digitized by Google

actuated by separate shafts running at half the speed of the crank-shaft, and operated by long skew gears on separate vertical shafts. The latter rotate in opposite directions, and turn the valve shafts in the same direction. By means of a vertical screw and hand-wheel, the skew gears can be raised or lowered, causing a relative angular displacement of the two valve shafts in opposite directions, and causing cams on these shafts to assume the relative positions requisite for forward or backward running, as desired. The lower ends of the top cylinders are closed, and communicate each with a piston valve, operated by the heart-shaped cams on the admission-valve shaft. The end and middle ports of the piston-valve casings communicate with a four-way cock, while the two intermediate ones communicate with the cylinder. The top branch of the cock communicates with a compressed-air receiver,



and the bottom branch with the atmosphere. In the accompanying illustration, which represents a front elevation, partly in section, the cock is in the running position, in which air from the receiver constantly acts on the lower sides of the top pistons during both up and down strokes. This gives a turning moment equivalent to that of a three-crank steam engine. Starting is effected by first putting the skew gears into the position for running either forward or backward, and then turning the four-way cock so that the end ports communicate with the air-receiver, and the middle ports with the atmosphere, thereby causing the top cylinders to act as compressed-air motors, without interfering with the action in the combustion ends of the cylinders. The capacity of the air-receiver need not be large, as the action in the combustion ends will be started in from two to ten revolutions, according to the compression in them. It is pointed out that the action of the cams and skew gear is such as to make them equivalent to three sets of link motion reversing

Digitized by Google

gear. For rolling-mill engines, or others liable to pull up dead in the middle of a power-stroke, the cylinders can be emptied, by the use of longer skew gears, before starting in the opposite direction. By using a sufficiently large air-receiver, an unusual resistance, such as that due to a sticking ingot, may be overcome, the power of the engine being temporarily doubled by putting the four-way cock into the starting position while the engine is running. The engine illustrated is governed by throttling, but a variable expansion of the charge, according to the power required, can be obtained by providing an independent adjustment for the admission-valve shaft skew gears.

G. W. DE T.

960. *Burger Gas and Gasoline Engine.* (Power, N.Y. 28. pp. 655–656, Nov., 1908.)—A description with succinct illustrations of a new type of internal-combustion engine working on the Otto cycle. The distinctive feature consists in the inlet valve and the hollow cylindrical governing valve. The former is opened by the suction of the piston, only on the suction stroke, the admixture of gas for each working stroke depending on a hollow cylindrical governing valve moved by a rod from the governor, which is of the flywheel pattern. The action of the governor is to rotate a pin, carrying the governor rod, in relation to the main crank and so change the time of the cut-off of the gas for mixing with the air charges. Different amounts of gas are therefore admitted according to the load, the intensity of the explosion being thus regulated. The exhaust valve is of the usual type, being operated by a system of gear wheels and a cam. The electrical ignition is effected by a make-and-break contact. An inlet valve for a gasoline engine, governed on the "hit-and-miss" principle, is also shown. No details are given as to efficiency of regulation or gas consumption, nor are there any indicator cards shown.

W. P. D.

961. *Gas Producers and Engines.* **R. W. A. Brewer.** (Mech. Eng. 11. pp. 460–464, April 4, and pp. 500–502, April 11, 1908. Paper read before the Civil and Mechanical Engineers' Society.)—After discussing generally the economic advantages of using producer and blast furnace gas for power purposes, the author makes various suggestions relative to the design of large gas engines. He considers that too much stress cannot be laid upon the importance of a good positive scavenger. He insists on the importance of duplicating the ignition gear, and, where electric ignition is employed, advocates the American system of using a three-way switch, by means of which the current can be reversed at will. Since the minute particles, the adherence of which gives rise to dirty sparking plugs, follow the direction of the current, periodical renewal considerably increases the life of the plugs. The use of petrol for starting large gas engines is recommended. Such a starter occupies very little space compared with compressed-air cylinders, and is always ready for use. The angular setting of the brasses of horizontal gas engines is deprecated. There is no reason in favour of it, as the wear invariably takes place vertically downwards, and adjustment can only be made perfectly with horizontally divided brasses. Moreover, the angular arrangement subjects the bolts to shocks, which should be distributed over solid masses of metal. The author maintains that therefore the best practice is to construct horizontal engine beds on the girder principle, having solid pedestals to carry the weight of the crank-shaft and flywheel. The brasses can then be fitted in, horizontally divided, and the lugs of the pedestals bound firmly together with tension caps. The small end of the connecting rod should have an easily accessible

Digitized by Google

fine adjustment, *e.g.*, by means of wedge gear, to remedy knock, which soon appears unless, as in the case of the Premier engine, reversal of stress in the moving parts is prevented from occurring at the end of the exhaust stroke. For many other practical suggestions the original paper must be referred to.

G. W. DE T.

962. *Blast-Furnace Gas Engines and Steam Engines.* (Engineering, 75. pp. 694–696, May 22, 1903.)—The paper consists mainly of a report by H. G. Scott on the working of the Cockeril engines described by Cochrane [see Abstract No. 456 (1903)], containing many valuable data. Comparing the efficiency of the gas engine with that of a steam engine absorbing 20 lb. of steam per i.h.p. per hour, fired with uncleaned hot blast-furnace gas, he finds the former to be 25·43 per cent.; while the combined engine and boiler efficiency in the latter case is 6·732 per cent. The latter would be diminished by about 20 per cent. if the gases were cooled and cleaned before burning them under the boiler, as is done before burning them in the gas engine.

G. W. DE T.

AUTOMOBILISM.[1]

963. *Miesse Steam Car.* (Automotor Journ. 8. pp. 292–295, March 21, and pp. 323–328, March 28, 1903.)—A detailed and fully illustrated description of this car, which externally resembles a typical petrol car. A flash boiler, located in front under a bonnet, using paraffin oil for the burner, supplies steam to a completely enclosed horizontal three-cylinder single-action engine of 6 or 10 h.p., having mechanically operated inlet and exhaust valves, like a petrol engine. The cranks are 120° apart, the crank-shaft being transversely placed in the car and gearing direct on to a transverse differential counter-shaft, from which the drive is by side chains to the road wheels. The capacity of the fuel reservoirs is sufficient for 150–120 miles, that of the water tank being 80–100 miles. Lettered illustrations of the parts, and diagrams of the steam, water, and fuel systems are given. L. H. W.

964. *Chaboche Steam Car.* (Automotor Journ. 8. pp. 316–318, March 28; 427–429, April 25; 452–456, May 2; and pp. 501–502, May 16, 1903.)—A description of this car which is externally similar to the Gardner-Serpollet carriage, though lighter in appearance. It has a flash boiler, with helically-wound coils located at the rear, separate vapourisers for each of the six burners, and a 12-h.p. two-cylinder double-acting horizontal engine with ordinary slide-valves. Transmission from the crank-shaft is by two-speed gear and jointed tail-shaft to the rear live-axle. A foot accelerator is provided, for increasing the boiler pressure, and automatic devices for regulating the burner and controlling the feed-water. The illustrations are numerous and include lettered descriptions of all the parts in detail, with a coloured diagram of the water, steam, fuel and lubricating systems. L. H. W.

965. *Crouan Petrol Car.* (Automotor Journ. 8. pp. 497–500, May 16, and pp. 529–532, May 23, 1903.)—This is a well-illustrated article describing the construction and details of the 6½-h.p. light car, which presents a number of unusual features. The motor is a two-cylinder horizontal one, with the cylinders opposed to one another (though not quite 180° apart) and is placed transversely in the chassis. The flywheel, which is unusually small, forms

[1] Electric Automobiles are described in the Section dealing with Electric Traction.

Digitized by Google

the middle member of a double-cone main clutch driving the first-motion shaft of the change-speed gear. This first-motion shaft has six gear wheels on it cut out of the solid, providing five speeds forward and one reverse. There are large jaw-clutch members on the second-motion shaft gear-wheels, and corresponding two-way clutches on feather keys on the shaft between each pair of wheels. These clutches are controlled by forked pivoted levers carrying small rollers running in cam grooves in three cams on the cam shaft. The cam-shaft itself is rotated by turning a handle on a sleeve on the steering pillar. When this handle points forward, the gears are all out, and each gear is put in successively until, when it points towards the driver, the top gear is in. If the hand lever is turned about its own axis (like a stop-cock), it actuates a throttle valve on the Crouan carburettor. This latter is very fully described as well as the Espinasse carburettor, which is used on the larger cars. L. H. W.

966. 15-*H.P. Georges Richard Car.* **L. Fournier.** (Locomotion Automobile, 10. pp. 54–59, Jan. 22, 1908.)—A description of the 1908 type of this car. The chief feature is the magneto for the ignition, driven at the same speed as the motor, and the mechanical device by which the break is made with great suddenness; the ignition can be advanced or retarded. A centrifugal governor acts on a conical valve in the induction pipe. Control may also be effected by varying the quantity of mixture taken from the carburettor, by means of another hand-operated conical plug in the carburettor. Otherwise, the transmission follows the usual lines of a gear-driven live-axle type of car. L. H. W.

967. *Benz "Parsiful" Petrol Car.* (Motorwagen, 6. pp. 28–30, Jan. 31, 1908.)—The 1908 type of this car is made in the following sizes: 8–10 h.p., 10–12 h.p., and 12–14 h.p., the motor in each case having two cylinders and being located under a bonnet in front, the whole car now conforming to the standard type of petrol car with gear driven live-axle. The valves are all mechanically operated, of large size and easily accessible. The carburettor is of the R. Benz atomising type, both air and gas supply being adjustable. The governor acting on the carburettor gives a range of speed between 800 and 1,200 r.p.m., regulated from the seat. The pump is gear-driven. The clutch is of the internal-spring type, any end pressure being taken up by ball-thrust bearings. Three speeds and reverse, with direct drive on top speed, are provided. L. H. W.

968. *Dietrich - Bugatti Petrol Car.* (Automotor Journ. 8. pp. 396–398, April 18, 1908.)—A description of this car with illustrations of the 24-h.p. chassis. The chief feature is the motor, each pair of cylinders, 110-mm. bore and 130-mm. stroke, being cast in one piece without a water-jacket, and each casting then enclosed in a circular aluminium casing (thus the four cylinders externally look like two cylinders of enormous dimensions). The valves are all fitted in the heads of the cylinders on the top, and are all mechanically operated by means of cam-shafts placed on each side of the crank chamber for the inlet exhaust valves respectively, though the precise manner in which the valves themselves are actuated is not clear from the drawings. A belt-driven fan for cooling the honeycomb radiator is provided. The car otherwise follows the usual lines of a side-chain driven car with four speeds and reverse. Control is by governor acting on the throttle, giving a range of speed from 250 to 1,400 r.p.m. L. H. W.

Digitized by Google

969. *Rochet-Schneider Petrol Car.* (Automotor Journ. 8. pp. 470–475, May 9, 1908.)—A description with illustrations of the 16–20-h.p. 1908 type of this car. Though following the usual lines of a side chain-driven car, there are one or two special features, among which is the stationary clutch spring, which can be adjusted while the engine is running. Two water-cooled brake-drums are mounted on the countershaft, one on each side of the gear-box, and operated by independent pedals. The ends of the countershaft are provided with ball bearings close to the sprocket wheels. The change-speed lever can be moved forward or backward in either of two parallel slots, and sideways from one slot into the other when in its central position. In the one slot, when pushed forward it gives the first speed, when drawn backwards, the reverse speed. In the other slot, the second speed is put in by pushing back the lever, and the third and fourth, successively, by pushing it forward, a catch being provided to prevent the reverse being put in accidentally; the catch can be withdrawn by the foot. The four-cylinder engine gives 22 b.h.p. and has mechanically operated valves and magneto ignition. The carburettor has two butterfly valves, controlled by the governor and accelerator pedal, connected together to keep the quality of the mixture constant. L. H. W.

970. *Continental Petrol Cars.* (Automotor Journ. 8. pp. 558–561, May 30, 1908.)—A description of the various sizes of these cars from 6–24 h.p. All are fitted with Henriod engines [see Abstract No. 19 (1908)], the carburettor used being of the Henriod mixing type on the single-cylinder size, and on the larger sizes the Espinasse [see Abstract No. 965 (1908)]. The cars are all of the longitudinal shaft with live-axle type. L. H. W.

971. *Chenard and Walker* 14-*H.P. Petrol Car.* (Automotor Journ. 8. pp. 874–878, April 11, 1908.)—A description, with plan and elevation of the chassis, of this car, which resembles the 10-h.p. size described in Abstract No. 620 (1908) in most features, the chief difference being in the transmission to the road wheels, which now takes place through a jointed tail-shaft to a false live-axle containing the differential, provided on each side with a pinion which meshes into internally toothed drums made in one piece with sleeves fitting over the fixed axle and forming the bearings for the road wheels. Improvements in the control of the centrifugal governor actuating the valve-lift cam are also described and illustrated. L. H. W.

972. *Mors Cars.* (France Automobile, 8. pp. 24–29, Jan. 11, 1908.)—A description, with illustrations, of the 1908 types of 11 h.p. and 18 h.p., the motor in both sizes having four cylinders and the valves all being mechanically operated and interchangeable. The chief feature is the transmission to the transverse differential countershaft. This latter has two bevel wheels mounted on it, the one slightly to one side, and the other, on the differential box, somewhat towards the other side. At the three lower speeds the drive takes place through the sliding gears and second-motion shaft bevel wheel, which gears into the former of the two bevels on the transverse countershaft. When the train balladeur, however, is slid along to the position for the top or fourth speed, the gears on it are quite free of the second-motion shaft, and notches at the end of the train balladeur fit into projections in the collar of the bevel-wheel gearing into the second bevel wheel (on the differential) on the countershaft, thus making the drive direct from the clutch to the countershaft. L. H. W.

Digitized by Google

973. *40-H.P. Hart Petrol-Electric Car.* (Automotor Journ. 8. pp. 359–360, April 4, 1908.)—Photographs of this car are given. The transmission is electrical, a four-cylinder petrol engine (with inlet valves arranged above the exhaust valves, and mechanically operated from an enclosed cam-shaft which passes above them and is driven by a chain from the engine) driving a 20-kw. dynamo, located just behind it, by means of a flexible coupling. The dynamo is of the enclosed four-pole type. Current is taken through a controller to an electric motor fixed on the main frame just behind, and with its shaft parallel to the transverse differential countershaft, from which side-chains drive the road wheels. L. H. W.

974. *Garreau Motor-Bicycle.* **L. Fournier.** (Locomotion Automobile, 10. pp. 278–282, April 30, 1908.)—The air-cooled motor has the cylinder cast with its cooling ribs and the upper half of the crank chamber in one piece, the under half being also a single piece, and the joint between the two halves horizontal, obviating leakage of oil. The flywheel, which may be readily removed, is on a taper on the shaft and is placed outside the case, and the driving pulley, being bolted to the inner side of the wheel, can easily be replaced by one of a different size. A belt drive is used. L. H. W.

975. *24-H.P. Pascal Car.* **M. Chérié.** (France Automobile, 8. pp. 41–44, Jan. 18, 1908.)—This car, which is much on Panhard lines, has one or two special features. The motor has four cylinders, 120 mm.-bore, 130 mm.-stroke, with suction inlet-valves. No regulator is provided, the flexibility of the Mercedes carburettor, which is fitted, being considered sufficient. The clutch is of the metal to metal type, two oppositely situated segmental members being expanded into a groove in the flywheel; thus no end pressure is applied to the shaft or bearings either in letting in or releasing the clutch. The expansion is caused by springs, bell-cranked arms, moved by a sliding cone on the shaft, releasing the grip. Internal expanding-ring brakes are provided on the rear wheels. L. H. W.

976. *Light Petrol Cars on Railways.* **L. Pierre-Guédon.** (Génie Civil, 42. pp. 404–406, April 18, 1908.)—An illustrated article describing two such cars. The first is a de Dion motor quadricycle for use as an inspection car. This resembles the ordinary quadricycle, the only difference being the four flanged wheels for running on the metre-gauge rails. It is driven by a 3½-h.p. water-cooled motor. The car at present is used for postal purposes between Noyelles and Cayeux. The speed obtainable is 20–40 km. per hour, and total weight 800 kg. The second, a larger 6-seated vehicle for the Valmondois line, is destined for passenger traffic and carrying messages. It has a roof and storm curtains. A single-cylinder engine, 110-mm. bore, 130-mm. stroke, placed forward, drives the rear live-axle by central bevel gear, two speeds being provided. The weight is 1,100 kg., and speeds up to 40 km. per hour are obtainable on the level. L. H. W.

977. *Steam Motor Coaches on Railways.* (Engineer, 95. p. 372, April 10, 1908.)—A description of the steam-driven motor coach for use on the L. & S.W. and L.B. & S.C. Railways as joint stock between Fratton and Havant. Length of frame 56 ft. There are two four-wheeled bogies, one of which supports the boiler and engine. The two cylinders are 7-in. bore, 10-in. stroke, the connecting rods driving direct on to pins on the front wheels

Digitized by Google

of the foremost bogie. The car holds ten first, and thirty-two third-class passengers, and one ton of luggage, and can, if necessary, be driven from either end. It bears a remarkable resemblance to a motor coach described in the Engineer 127. p. 154, February 26, 1869, over thirty-four years ago.
L. H. W.

978. *Napier Steering Gear.* (Automotor Journ. 8. p. 563, May 30, 1908.)—This differs from the Denis gear [see Abstract No. 755 (1908)] in that it consists of a worm wheel and toothed quadrant. Any wear which would allow the worm wheel and its shaft to move longitudinally can be compensated for by means of an adjustable set screw. The quadrant is so made that it can be brought into true mesh with the worm wheel by feeding it forward along a machined slot, after slackening a locking stud. The lever arms for the respective steering heads are fitted with ball joints. The illustrations clearly show the details of the mechanism. W. P. D.

979. *Ball Bearings.* **M. J. Golden.** (Eng. News, 49. p. 129, Feb. 5, 1903. From a paper read at the annual meeting of the American Association for the Advancement of Science.)—The author made a series of tests, about three years ago, to determine a formula for use in designing ball bearings of the small sizes commonly used, when the plane of rotation of the balls is perpendicular to the axis of rotation. The tests were made on balls that were respectively 0·25 in., 0·3 in., and 0·5 in. in diameter, and at speeds varying from 200 to 2,000 r.p.m. It was found that when the speed was over 2,000 r.p.m., and especially above 5,000 r.p.m., that a chattering action was liable to occur in the bearing, and the friction would suddenly become excessive, usually necessitating a stoppage of the testing machine. At high speeds, above 2,000 r.p.m. in the tests made, there was a tendency for the bearing to chatter, and this tendency was more marked with the heavier loads, with the less accurately ground balls, and with the softer balls and races. The balls and races were destroyed by first becoming pitted, and this pitting showed on both balls and races. With the heavier loads, the balls were destroyed by breaking into two parts that seemed to have been sheared asunder. The balls and races became hot, before loads were reached that tended to destroy them. The tendency to heat and to chatter were reduced in a marked degree by the use of a lubricant, oil giving the best results. Calculations from the figures taken during the test gave the coefficient of friction to be 0·00475, or less than one-half of 1 per cent.; though in a few of the tests the figure was found to slightly exceed one-half of 1 per cent. The friction was slightly greater with the smaller balls and at the higher speeds. The formula deduced was $F = L\{0{\cdot}005 + 0{\cdot}001/d + 0{\cdot}005D\}$, where D = diameter in inches of the path of the balls on the races, d = diameter of the balls; L = load in lbs.; F = friction. The balls were all of steel, accurately ground, and tempered as hard as possible. Owing to the small range of size and the uniformity in hardness, the formula must be accepted with reservation. G. W. DE T.

980. *Greth Airship.* **A. Inkersley.** (Scientific American, 89. p. 327, Nov. 7, 1903.)—This article contains an account of the ascent over the city and bay of San Francisco by A. Greth in an airship of his own invention. After reaching an altitude of 2,000 feet, a descent was made into the bay. The airship was of the dirigible balloon type, the balloon when inflated having a length of 75 feet and a maximum diameter of 25 feet. Propulsion was effected by a gasoline motor, developing 6 h.p. and weighing 500 lbs.,

Digitized by Google

driving two fans. At an altitude of 2,000 feet, and after carrying out some semicircular evolutions, and ascending and descending, the motor broke down, compelling the aeronaut to release some of the gas and descend. The balloon is without the automatic expansion valves employed by Santos Dumont. The frame is within 7 feet of the balloon, it being claimed that this adds to the dirigibility. W. P. D.

REFERENCES.

981. *Hospitalier's Indicator.* (Automotor Journ. 8. pp. 40–41, Jan. 10, 1903.)—Three views are shown. The principle is that of deflecting a beam of light by a small mirror which is subjected to two sets of impulses. One of these is proportional to the pressure in the working cylinder, and the other corresponds with the movements of the piston. C. C.

982. *Indicating High-speed Engines.* **A. M. Arter.** (Engineer, 95. pp. 249–251, March 6, 1903. Paper read before the Civil and Mechanical Engineers' Society, Jan. 8, 1903.)—The author gives a number of defective diagrams and states to what causes the defects were due, and the methods by which they were remedied. H. R. C.

983. *Recent Steam Turbine Applications.* **G. L. Parsons.** (Cassier, 24. pp. 64–70, May, 1903.)—Data are given of the performances of various sizes of turbines, and instances are referred to of the use of the steam turbine for driving pumps, fans, blowing engines and air compressors. G. W. DE T.

984. *Boiler Explosions.* **C. Bach.** (Zeitschr. Vereines Deutsch. Ing. 47. pp. 160–164, Jan. 31, 1903. Paper read before the Württemberg local section, Nov. 23, 1902.)—A discussion of some recent boiler explosions [see Abstract No. 744 (1903)], with conclusions to be drawn from them. W. H. S.

985. *The "Series-Vapour" and "Heat-Waste" Engines as Supplementary to Single-Vapour Engines.* **R. H. Thurston.** (Frank. Inst., Journ. 154. pp. 291–314, Oct.; 367–390, Nov.; and pp. 447–479, Dec., 1902.) C. C.

986. *Liquid Fuel.* **H. F. Schmidt.** (Amer. Electn. 15. pp. 118–120, March, 1903.)—This article contains some practical considerations as to the advantages and disadvantages connected with the use of oil as fuel. F. J. R.

987. *Liquid Fuel for Steam Raising.* **A. L. Williston.** (Eng. Mag. 25. pp. 237–252, May, 1903.)—After giving some examples of the extent to which liquid fuel is coming into use in the United States, the author discusses, with examples drawn from recent practice, the principles governing the design of burners and furnaces for the consumption of liquid fuel under boilers. G. W. DE T.

988. *Bearings for High Speeds.* **F. Drouin.** (Écl. Électr. 34. pp. 352–355, March 7, 1903.)—Abstract of an article by M. Lasche in Traction and Transmission, Jan., 1903, descriptive of exhaustive experiments made, on bearings running at turbine speeds, to demonstrate the close connection existing between work transformed into friction, friction heat, the permanent temperature of bearings dependent on the means adopted for dissipating heat, and the permissible degree for the permanent temperature. The experimental apparatus is fully described and illustrated by means of photo reproductions. Curves showing the relationship between the coefficient of friction and temperature, pressure speed, and bearing metal, are given. [See also Abstract No. 816 (1903).] F. B.

Digitized by Google

INDUSTRIAL ELECTRO-CHEMISTRY, GENERAL ELECTRICAL ENGINEERING, AND PROPERTIES AND TREATMENT OF MATERIALS.

989. *Accumulator Plates.* **E. Leimer.** (Centralblatt Accumulatoren, **4.** pp. 1–8, Jan. 1, and pp. 15–17, Jan. 15, 1908.)—The writer is the inventor of several processes connected with different binding materials required for making the oxide paste. The use of phenol is especially described. This with lead peroxide forms a basic phenylate when an aqueous solution is employed. One part of pure (98 per cent.) carbolic acid is mixed with 15 parts of distilled water. Red-lead or litharge is moistened with the solution and then kneaded into a paste and pressed into the grids. The necessary precautions required in making *positive* plates by this method are fully described. The processes for the negative plates are also detailed. Attention is called to the fact that if freshly formed positive and negative plates be short-circuited when in acid, loud explosions and flashings are produced and the plates are burst into pieces. Further, if a few drops of pure glycerine be dropped on a freshly formed positive plate an extremely violent explosion of dangerous character results after a short time. [See also Abstract No. 864 (1908).] W. W. H. G.

990. *Possibilities for a Light-weight Storage Battery.* **A. L. Marsh.** (Elect. World and Engineer, **39.** pp. 996–998, June 7, 1902.)—This paper deals with the storage battery, with special reference to the needs of electric traction, and is of interest in view of the Edison nickel accumulator. The author points out that the ampere-hour capacity depends upon the equivalent weights of the elements involved in the reactions of charge and discharge, and not upon their specific gravity, and then shows that by this method the theoretical capacity obtainable is, as is well known, 101·58 ampere-hours per lb. of positive active material, though in practice only about 82 ampere-hours is obtained at a 4-hour discharge rate, 50 per cent. of the theoretical capacity seeming to be the limit. He then considers the yield with some other elements and compounds in the place of lead, giving tables for various positive and negative materials as follows :—

Positive Materials.	Ampere-hours per lb.	Negative Materials.	Ampere-hours per lb.
PbO_2 to $PbSO_4$	101·58	Pb to $PbSO_4$.....	117·27
NiO_2 to NiO	267·85	Fe to Fe_2O_3	650·0
NiO_2 to Ni_2O_3	133·92	Fe to FeO	433·34
Ni_2O_3 to NiO	146·88	Fe to Fe_3O_4	577·79
AgO to Ag	195·70	Cd to CdO	216·67
Ag_2O to Ag.....	104·6	Zn to ZnO.....	378·3
CuO_2 to Cu.....	507·9	Zn to $ZnCl_2$	378·3
CuO_2 to CuO	253·95	Cu to CuO.....	381·53
CuO to Cu	304·74	Cu to Cu_2O	190·76
Cu_2O to Cu	169·44		
Chlorine.....	342·27		

The three reactions given for nickel are those represented by Edison's, the author's, and Michalowski's theories (respectively) of the reactions in the discharge of the nickel accumulator. Of positive materials, lead peroxide stands lowest in ampere-hour capacity per unit weight, and the value would

Digitized by Google

be lower still if account were taken of the acid withdrawn from the electrolyte during discharge. The other materials in the list (except chlorine) are used in alkaline solution. Such an electrolyte is unchanged as a whole, and need only be in sufficient quantity to serve as a conductor and allow for decomposition of water in overcharging. Copper peroxide gives the greatest capacity of all, but has not been used for storage purposes, as it would have to be maintained at near the freezing-point; it decomposes, when in the moist state, at ordinary temperatures. The author then points out that in a consideration of light-weight accumulators, it is watt-hour capacity, not ampere-hour capacity, which counts, thus the voltage must be taken into consideration. The following table is then given of the e.m.f.'s of positive and negative materials in alkaline solution (the positives referred to silver oxide as zero standard; lead, requiring an acid electrolyte, being excluded):—

Positive Material.	E.M.F.	Negative Material.	E.M.F.
Nickel peroxide...	+ 0·4 volt.	Zinc (amalgamated)...	1·37 volt.
Silver peroxide ...	+ 0·15 „	Zinc (pure).....	1·32 „
Silver oxide.....	0 „	Cadmium	0·95 „
Copper peroxide...	+ (?) „	Iron.....	0·85 „
Cupric oxide	− 0·4 „	Copper	0·56 „
Cuprous oxide ...	− 0·47 „		

Thus a copper peroxide zinc couple (with potassium hydroxide solution as electrolyte) should give a high voltage, but no experimental determination has yet been given. Black oxide of copper gives a voltage of 0·8 to 0·9, yet even with this low e.m.f. its watt-hour capacity is greater than that of lead peroxide. The chief difficulty in practice with this Cu-Zn combination seems to lie in the deposition of the zinc. Nickel peroxide gives a voltage of about 1·5 (with iron) at the beginning of discharge, the average being little over 1 volt. The ampere-hour capacity is rather high if Edison's theory be correct; by the author's theory the watt-hour capacity is rather low, the advantage in weight over the lead cell being due chiefly to the iron negative and the small amount of electrolyte required. The capacity of silver peroxide is quite high, and the e.m.f. only slightly below that of nickel peroxide, and it does not drop rapidly. (Reference is then made to the carbon-zinc cell of Pisca, using chlorine as depolariser.) Of the negative materials iron has the greatest ampere-hour capacity, and also a high e.m.f., and the author considers that the peculiar property of inertness of iron and its oxides will be no serious obstacle to their use for accumulators. Cadmium has a smaller capacity than iron, and is very expensive. Copper has a high capacity but low e.m.f., and slight solubility. Zinc is used in a recent cell of Michalowski as negative in an electrolyte of sodium or potassium aluminate. Zinc is insoluble in this solution, and gives a higher e.m.f., greater capacity, and is cheaper, than cadmium. Lastly, the importance of the grid is referred to. In the best plates this is about half the weight of the plates. A much less weight of iron or nickel will support the same amount of active material found in the lead grid, reducing the proportion of grid to active material to about 1:2, the percentage weight of grid being quite capable of a much further reduction. In conclusion, the author considers that, though lead accumulators have shown themselves well adapted for central station work, for traction purposes a cell of greater durability and lightness is required, and he thinks that, to this end, attention should be directed chiefly to the study of those metals and compounds which present greater possibilities than lead.

L. H. W.

Digitized by Google

991. *Deterioration of Storage Battery Plates.* **A. L. Marsh.** (Elect. World and Engineer, 40. pp. 409–411, Sept. 18, 1902.)—The author refers to his previous paper on the possibilities for a light weight accumulator [see preceding Abstract], and now points out that in traction work durability is of even greater importance. In actual practice the negatives certainly lose their capacity, but so slowly that they can be used with several sets of positives. The positive plate, as the weak point in the cell, is then more particularly considered. When the cell stands discharged, rapid sulphation takes place, and also less rapidly under other conditions, although by careful treatment the sulphation can be reduced to some extent. Another cause of deterioration is lack of porosity in the active mass. In pasted plates the peroxide mass softens under severe service in an automobile, and tends to wash away from the grid, forming a sediment which must be removed periodically. Covering of the plates with porous substances may help somewhat, but cannot prevent the formation of sediment, which the author thinks is due to the lead sulphate which is soluble in concentrated sulphuric acid, practically insoluble in dilute acid, and slightly soluble in pure water. Thus, in charging a cell at a high rate, acid is liberated faster than it can diffuse out, therefore the interior of the plate contains concentrated acid in which the sulphate is soluble. This acid with the sulphate in solution slowly diffuses out from the plate and is diluted by the weaker acid, when the sulphate is precipitated and settles on the bottom of the cell. This action would take place through any porous envelope and form a sediment just the same as without it. Cells other than lead are then considered. In the zinc-copper cell, with an alkaline electrolyte, buckling or sulphating is unknown, and the cell can stand in the discharged condition without injury. The zinc negative is, however, liable to local action. The charge should be low and intermittent; the life is short, and the time it retains its charge is comparatively short. In the nickel-iron cell the author considers it probable that, as in the lead peroxide plate, the actual capacity is only about half of the theoretical. According to his theory, the lowest oxide formed is Ni_2O_3, but under certain conditions the nickelous oxide might be formed, which is insoluble and is only slowly brought back to the proper condition. Overcharging is not hurtful, as with pure potassium hydroxide solution the nickel is not attacked by the nascent oxygen. Chlorides, nitrates, and tartrates should not be present. Cells of the zinc-chlorine type are considered out of the running for this purpose. Coming now to the silver cell, of which the Jungner cell [see Abstract No. 2809 (1900)] and the new Edison cell are examples, the author considers this to be the one best adapted to maintain normal reactions under severe conditions of service. The only difficulty is that the oxides are slightly soluble in the alkaline electrolyte, though it is possible this may be overcome by some change in the electrolyte. There is no tendency, however, to form compounds which cannot readily be brought back to the charged state, and the cell may be left in any state of discharge without injury to the plates. The author then arrives at the following conclusions: The lead cell has not received enough attention from its chemical and physical side. Investigations should be directed to methods for securing greater porosity and firmness in the active material of the positive electrode and to improving the electrolyte so as to prevent the formation of lead sulphate, or at least to render it insoluble in all densities of the acid solution, so that it remains in place and can be restored to the proper condition. Nickel is a strong metal compared with lead. Its peroxide belongs to that class of depolarisers which adds electromotive force to the

Digitized by Google

cell, and in this respect it is the best, so far, that it is practical to use in alkaline electrolytes. The electrolyte permits the use of steel for the grids and the containing vessel, and this gives a construction both light and strong. There seems to be no reason to believe that this cell will not do what Edison claims for it. Silver would be a good metal to use in traction batteries if its cost were not so great. The silver in a worn-out battery would go a long way toward paying for a new set, but the first cost would be rather great. In the lead cell the active material of the positive is only about half of the weight of the entire plate, so the weight of silver oxide required in the silver cell would correspond to the weight of lead peroxide, and not to the whole electrode. The other materials used would be inexpensive; nickel or steel for the positive grid and, probably, iron for both negative grid and active material. Experiments indicate that a silver battery, giving the same power as a lead automobile battery weighing about 550 lbs., would require only about 70 lbs. of silver oxide, and perhaps less. It would not take a very extraordinary reduction in the price of silver nitrate to make the cell practical from a financial standpoint, and for the reasons given above such a cell could be made to have a comparatively long life and high efficiency. L. H. W.

992. *Deterioration of Storage Battery Plates.* **M. U. Schoop.** (Elect. World and Engineer, 40. p. 657, Oct. 25, 1902.)—This paper constitutes a reply, with some additions, to a previous paper bearing the same title, by A. L. Marsh [see preceding Abstract]. The author first disagrees with Marsh's statement that the negative plates last two or three times as long as the positives, pointing out that, at least on the Continent, in cases where the life of the negatives is longer than that of the positives, it is simply because the ratio of the capacity of a new negative to a thoroughly-treated positive is as 1 : 2. The capacity of the positives diminishes as time goes on, and the negative capacity also diminishes owing to leading, though much more slowly. After two years the ratio between the capacities is only 1 : 1·5 about. After two more years, say, the grid is so far oxidised that new positives are required. Actual test of the negatives would show only half the capacity when new, and if new positives are put in, the rapid fall of voltage is now due to the giving out of the negatives. The author's evidence appears to show that, though the life of the negative is longer, the cases in which the second positive plates are renewed while the original negatives remain are very rare. In the case of traction batteries, in which a minimum of weight and space are essential, there is no longer any reason to give the negative a much greater capacity than the positive, and the lives of positive and negative plates in such batteries are about equal. Further, the space for the electrolyte is very small, and therefore a very concentrated solution must be used. Another point is the rise of temperature during the operation of the battery; in cases where hard rubber jars are placed close to one another, temperatures of 50° to 60° C. have been noted at the end of charge. Local action of the acid is least at 1·150 to 1·170 (at 15° C.), but for traction purposes the density is generally 1·250 to 1·300, and in this case the local action is three times that at 1·150. The author considers that too little attention is paid to this point, and that it is as difficult to construct a faultless spongy lead plate for traction purposes as it is to make a lead peroxide plate which has a long life. Finally, he agrees with Marsh that the sulphating is in a large measure responsible for the rapid destruction of the plates, and while also agreeing that the porosity of the active material determines the coefficient of usefulness of the latter, points out that were it possible to completely utilise the active mass present (coefficient of

Digitized by Google

usefulness = 100) instead of only about one-third, then three times the amount of acid would be necessary. He therefore regards the prospects of improving the life and capacity of the plates of the modern lead storage battery as very slight. L. H. W.

993. *Storage Batteries.* **H. Rodman.** (Amer. Electrochem. Soc., Proc. 2. pp. 177–182; Discussion, pp. 182–188, 1902.)—The author discusses the directions in which improvement may be anticipated. He maintains that the necessity of overcharge demands unchanging electrodes in an unchanging electrolyte. He concludes that this limits the available anodes and electrolytes to lead in sulphuric acid, and nickel in an alkaline hydroxide.

G. W. DE T.

994. *Electrolytic Separation of Mixed Metals.* **T. Ulke.** (Elektrochem. Zeitschr. 9. pp. 187–189, Dec. 1902, and pp. 215–217, Jan. 1903.)—A review of the various processes that have been proposed for separating by electrolysis the nickel and copper produced from Canadian ores. In order to render the process continuous and keep the electrical conditions constant, it is now proposed to use a copper kathode and an anode of the copper-nickel alloy with an acid electrolyte; the electrolyte tends to become poor in copper and rich in nickel, but is maintained of constant composition by removing at regular intervals a small percentage of the solution and replacing it by copper sulphate solution. The hot nickel solution is mixed with ammonia, or ammonium sulphate, and the nickel double-salt separated by cooling; the copper remains in solution, and is used for replenishing the bath in which copper is deposited. The nickel-ammonium sulphate contains a little copper, which is eliminated by repeating the precipitation; it can then be sold as such or used for preparing metallic nickel. In the latter case it is dissolved and electrolysed in an alkaline ammoniacal solution with a nickel kathode and lead anode; the lead anode is scarcely attacked, and the trace of lead that passes into solution and is deposited with the nickel, can be removed by fusion. The nickel-bath, which becomes poor in nickel and rich in ammonium sulphate, is maintained of constant composition by adding nickel ammonium sulphate, and removing part of the solution for use in precipitating a further quantity of the double sulphate. T. M. L.

995. *Electrolytic Reduction of Zinc Ores.* **S. S. Sadtler.** (Amer. Electrochem. Soc., Proc. 1. pp. 141–144; Discussion, pp. 144–146, 1902.)—The author considers that success in the electrolytic reduction of zinc is most likely to be attained by the use of alkaline solutions. He treats zinc blende with an alkaline oxidising agent, such as hypochlorite, and electrolyses the solution.

G. W. DE T.

996. *Hall Process for Aluminium Extraction.* **H. Becker.** (Ind. Électrochim. 7. pp. 17–20, April, 1903.)—The author deals with the Hall process as worked at the factory of the Compagnie des Produits Chimiques d'Alais at Calypso, near St. Michel, in France. The baths at Calypso take a current of 4,000 amperes, and are one metre in length, 55 cm. in width, and 20 cm. in height. The carbon anodes are hung by stirrup-shaped connections upon the copper conducting bars which run the length of the baths, and any one of these anodes can be raised or lowered as required. The fused material in the bath is covered with a layer of powdered charcoal which floats upon it, and reduces the loss of heat by radiation. The fresh alumina required by the bath is spread on top of this charcoal, and is only

Digitized by Google

pushed beneath it, when the increased e.m.f. taken by the bath, shows that its alumina contents are becoming exhausted. A small 10-volt incandescent lamp is attached to the circuit of each bath, and its brightness indicates to the workman in charge the state of the bath at any moment. The aluminium produced in the baths is removed at intervals of one hour, formerly by a syphon, but latterly by tilting the bath, which is specially mounted for this purpose. The aluminium at present produced in France contains 99·5 to 99·6 per cent. Al. A description of Hall's new processes for purifying bauxite concludes the article. J. B. C. K.

997. *Kjellin's Electric Furnace for Steel Manufacture.* **H. Becker.** (Ind. Électrochim. 7. pp. 9–11, March, 1908.)—This is an account of Kjellin's furnace used at Gysinge, in Sweden. It consists of an annular space for holding the molten steel, surrounded by refractory material, which is enclosed in a powerful electromagnet, which sets up an alternating induction current in the charge of metal contained in the annular space, and thus melts it. Various sized furnaces have been employed. The largest of these, with a current expenditure of 165 kw., produced 4,100 kg. of steel in twenty-four hours. Thermo-chemical calculations show an efficiency of about 75 per cent., which would have been even greater if the metal had been introduced in the molten condition in the central annular crucible. The cost of power, taking the h.p.-year at 50 francs, equals 10·2 francs per ton of steel. To this must be added other expenses, not counting the metal, amounting to 25 francs. O. J. S.

998. *Efficiency of Electrical Furnaces.* **J. W. Richards.** (Elektrochem. Zeitschr. 9. pp. 255–260, March, 1908.)—The author states that the quantity of heat necessary for electric furnace work in the main consists of two factors. Firstly, heat necessary to bring furnace to requisite temperature, and, secondly, heat required for bringing about the intended physical and chemical change of material. Size of furnace is of great importance on account of the radiation of heat. The larger the capacity the more efficient it is. Examples given of: 1. Simple heating without melting: Converting anthracite into graphite (Acheson); efficiency: 75 per cent. of the theory. Graphitising carbon electrodes, 38 per cent. 2. Simple heating and melting: Jacob's process of melting calcined bauxite, equals 74 per cent. 3. Heating and chemical alteration without melting: Manufacture of carborundum 76·5 per cent. 4. Heating, melting, and chemical reaction: Conversion of $BaSO_4$ into oxide and sulphide (United Barium Company), equals 60 to 75 per cent. Acker process, electrolysis of fused NaCl, equals 68 per cent. All these calculations, some of which are based upon approximate values, are arrived at by adding together the various calories required for the reaction, and comparing with the quantity of energy expended. O. J. S.

999. *Olivetti Recording Wattmeter.* **A. Bainville.** (Électricien, 28 pp. 289–296, November 8, 1902.)—A description of this wattmeter for alternating or continuous currents. The instrument is of the electro-dynamometer type, two fixed series coils surrounding two movable fine wire shunt coils. The couple of the movable bobbins is counterbalanced at any instant by the torsion of a spring, which tends to restore them to the zero position, the spring for this purpose being attached at its other end to a spindle driven through a worm by an electric motor (provided with a disc brake) which

Digitized by Google

ceases to drive as soon as the zero position is reached. For this purpose contacts are so disposed with a relay arm (placed between forks mounted on the movable bobbin spindle with a very small amount of play between the forks) that, while the motor ceases to work in the position of equilibrium (where the relay arm is midway between the contacts), a diminution of the couple exerted on the movable bobbins causes the relay arms to swing over to the other contact, and thus to actuate the motor in the reverse direction until a new position of equilibrium is found. By this means the variable resistance between the pen and the paper is eliminated. The motor-driven worm gears into another pinion actuating a rack, capable of sliding horizontally, on which the pen is mounted and also a pointer for reading on a separate scale. The meter is particularly described as connected up in a three-phase circuit, and illustrations of high-voltage transformers for use therewith are included, with diagrams of all the working parts. The energy consumption in the meter is about 55 watts in the 100-volt type of meter, made up of 18 watts in the fixed coils, 2·5 watts in the movable coils, and 85 watts in the motor. L. H. W.

1000. *Fricker's Maximum Demand Indicator.* (Electrician, 51. pp. 71–72, May 1, 1903.)—In this indicator there is a graduated glass tube having a bulb at each end and containing gas and also a small quantity of mercury. This tube is arranged vertically, with the mercury resting in the neck of the tube in the upper bulb, so as to form a gas valve. Round the lower bulb extends one turn of a resistance wire, the ends of which are attached to flat metal springs to keep it in tension round the bulb. When a current passes, the gas in the lower bulb is heated and expands, causing a definite amount of gas to be transferred past the mercury valve into the upper bulb. On cooling of the apparatus, the mercury is moved down into the tube by this transferred gas through a distance proportional to the maximum current. The tube with its fixed scale can be removed by pressing apart the springs holding the resistance wire, and the mercury then returned to the upper bulb by shaking. In the event of failure of the resistance wire, the springs come together and keep the circuit closed. Time lag = 10 min. (about). C. K. F.

1001. *Measurement of Electrical Power.* **J. Görner.** (Elektrotechn. Zeitschr. 28. pp. 838–840, April 17, and pp. 862–865, April 24, 1902.)—The author points out that all methods of measuring the energy of alternating-current systems which are based upon inductive effects are subject to a certain want of accuracy due to the difference between the actual wave curves of the currents and pressures and the ideal sine curve which is usually assumed in calculations, and as a consequence the value of the power-factor $\cos\phi$, worked out from the wattmeter readings, will be wrong also. Take two simultaneous waves of alternating pressure. They may be in phase or not; it is proved that an ordinary voltmeter would give correct readings for the sum of these waves only in the case of either wave curve being of the same character; otherwise serious errors are introduced, and consequently the well-known method of measuring energy by means of three voltmeters (and some other methods based on similar principles) will hold good for certain cases only, depending on the character of the wave curves. Wattmeters working on the principle of mutual attraction of currents are free from this fault, but the readings may still be incorrect for two reasons: the self-induction in the moving coil, and the phase distortion due to eddy currents in the stationary coil. The author gives a formula

Digitized by Google

for working out the necessary corrections, but admits after all that this formula cannot easily be checked, and that these corrections are not of much importance, so one had better rely on the readings as they are.

The firm of Hartmann and Braun make a new type of wattmeter in which these two sources of inaccuracy are reduced as much as possible. A portable type and a stationary one for switchboards are on the market, both arranged for a double scale. Some hints are given as to the handling and connecting up of these instruments in order to avoid mistakes and disturbing outer influences. A detailed description is given of the so-called two-wattmeter method of measuring the energy or the power-factor in a three-phase system. This consists in putting the two ampere-coils each in one phase and connecting the voltmeter coils each between its own phase and the third, *i.e.*, free one. It is then easy to arrive at the total energy power-factor of the system by combining the two readings. The method is available if there is no balancing lead connected to the neutral point, or, at least, if the balancing current is equal to zero. Some concluding remarks on the denomination of three-phase pressures are of interest for German readers only. FR. B.

1002. *Power Measurement in Three-phase Systems.* **C. Mann.** (Elettricista, Rome, 11. pp. 88–92, April, 1902.)—The author applies Steinmetz's two-wattmeter method to this well-known subject, and arrives at several formulæ showing the dependency between the self-induction of the system and the sense of the wattmeter readings. He also considers the case of watt-hour meters in this paper, the details of which, on account of their mathematical character, do not allow of abstracting. FR. B.

1003. *High-tension Oil-break Switches.* (Electrician, 51. p. 88, May 1, 1903.)—A description of a B.T.H. triple-pole oil switch having two breaks per pole, under oil contained in a removable case. The switches are used on the London United Tramways substations for the Hampton Court Branch, and each unit can deal with short-circuit of entire substation. Controlling rotary converters, overload devices are fitted to trip the switch, the station line switches acting on reversal of current. The overload connections are shown in diagram. The current transformers are placed in the outside legs of circuit, between the bus-bars, and main transformers should have their secondaries coupled to solenoids. An armature in each solenoid is attracted on a predetermined overload, opening a contact and permitting the coil to be energised. An armature is then sharply attracted and, through suitable links, the switch toggle is struck off its centre, thus opening the circuits. Reverse relays are wound with current and potential coils in opposition, leaving the armatures normally inoperative. On reversal of current both coils act conjointly to draw the armature up. W. E. W.

1004. *Empirical Formula for B-H Curve.* **I. Döry.** (Zeitschr. Elektrotechn., Wien, 21. pp. 185–186, March 29, 1903.)—The author finds that, by dividing the B-H curve into two portions, one of which lies below and the other above the knee or bend of the curve, an equation of the form $B = H \cdot 10^{p + qH}$ may be found to fit either portion of the curve. For the portion below the knee, n has the value 0·6, and for the saturation portion, the value 0·1. The constants p and q have different values for the two portions of the curve. The author gives tables which show extremely good agreement between experimentally determined values and those calculated by the aid of

Digitized by Google

the above formula. He suggests that considerable saving of time in magnetic measurements may be effected by determining two pairs of corresponding values of B and H for the lower, and two pairs for the upper region of the B-H curve, using the four points so determined to find the values of p and q for the two regions of the curve, and then calculating any desired number of intermediate values by using the formula. A. H.

1005. *Testing Alternate Current Switches and Fuses.* **G. W. Howe.** (Elect. Rev. 52. pp. 725–726, May 1, 1903.)—The severity of a test on switch or fuse is now recognised as dependent on the power-factor of the current broken as well as current and voltage of circuit. The power-factor's effect on the energy of the arc can be shown. Introductory calculations evolved the following power-factor—

$$= \frac{P}{\sqrt{r^2 \times w^2 L^2}} = \cos \phi$$

where—

P = resistance in series with switch.
r^2 = resistance introduced on opening switch.
L = inductance across terminals.

$$\text{Maximum power of the arc} = \frac{Ee}{2}\left(\frac{1}{1+\cos\phi}\right) \text{ watts,}$$

$$\text{and } \frac{\text{Maximum power of arc}}{\text{Power in circuit before breaking}} = \frac{1}{2\cos\phi\,(1+\cos\phi)} = K.$$

For $\cos\phi = 1$	$K = 0{\cdot}25$
$\cos\phi = 0{\cdot}5$	$K = 0{\cdot}67$
$\cos\phi = 0{\cdot}1$	$K = 4{\cdot}55$
$\cos\phi = 0$	$K = \infty$

Example: Current of 100 amperes opened in series with non-inductive resistance across constant voltage of 1,000, maximum number of watts in arc =

For $\cos\phi = 1{\cdot}0$. $100 \times 1{,}000 \times 0{\cdot}25 = 25{,}000$ watts.
$\cos\phi = 0{\cdot}1$. $100 \times 1{,}000 \times 0{\cdot}1 \times 4{\cdot}55 = 45{,}500$ watts.

A convenient method of breaking switches and fuses is to put them in circuit with a number of choking coils, which, with variable air-gaps and alternative connections, allow of a wide range of currents and voltages. The test is made more severe by reason of low power-factor, but this is a good fault, quite allowable for. W. E. W.

1006. *Testing of Iron.* **B. Soschinski.** (Elektrotechn. Zeitschr. 24. pp. 292–294, April 16, 1903.)—This paper is a mathematical investigation of the magnitude of the error which occurs in the measurement of the hysteresis and eddy-current loss with certain forms of testing apparatus (such as those of Epstein and Siemens and Halske) in which there is a definite amount of magnetic leakage, the calculation of the loss being based on the assumption of a uniform induction along the specimen (as in a closed ring uniformly wound over). The author shows that the loss as measured by a wattmeter in such cases always gives a result in excess of the true value. He further shows that, even under the most unfavourable conditions which can occur in practice, the error does not exceed ½ per cent., and is therefore negligible.
A. H.

Digitized by Google

1007. *Effect of High Potential on Mica.* **J. Härdén.** (Elect. World and Engineer, 41. pp. 651–652, April 18, 1908.)—Andrews states that a thin sheet of mica which would stand in air 10,000 volts alternating, breaks down at 4,000 or 5,000 volts if dipped in oil. If a sheet of mica is placed between a point and a disc, the discharge from the point is spread over the whole surface, and therefore the electric pressure per unit surface is less. If a drop of oil is now placed on the plate, the oil will be driven out in a cup shape round the point. The walls of the cup concentrate the discharge round the point, and the electric pressure per surface unit is higher. The same phenomenon takes place if paraffin or stearine are used, and, further, an even lower potential difference would break down the mica, if a ring of sealing-wax was placed around the discharging-point instead of oil. The explanation of this appears to be that the oil circle is driven out by the discharge, whereas the sealing-wax is not, and the surface is therefore larger with oil than with sealing-wax. If a semicircle of paraffin or sealing-wax was placed round the point, the insulation did not break down, but the discharge was driven out through the opening in the circle. Without a change of potential difference in the spark, the circle assumed a closed-wall shape, and then the insulation broke down. M. O'G.

1008. *Examination of the Atmosphere of the Central London Railway.* **F. Clowes.** (Soc. Chem. Ind., Journ. 22. pp. 404–405, April 15, 1908.)—An account of the chemical and bacterial examination into the above question. The recommendation is that the air should not contain more than 8 volumes of CO_2 per 10,000 of air. Examination showed that of 89 samples, 22 per cent. contained less than 8 per cent. CO_2, and 34 per cent. contained less than 12 per cent., so that not very much improvement in ventilation is required. O. J. S.

1009. *Lowne System of Electric Clocks.* (Electrical Times, 28. p. 833, May 21, 1908.)—In this system the pendulum-fork of the primary electric clock bears a feed-pawl which intermittently rotates a half-cylinder, and this half-cylinder alternately separates two pairs of contacts, of which each pair is connected to one of two oppositely arranged electromagnets in the secondary clock. These electromagnets act on a common armature which is mounted on the lever of a two-way switch controlling the two electromagnets just referred to. Assuming the circuit of one of these electromagnets to be completed, the lever of the two-way switch will be moved, thereby breaking the circuit by cutting this electromagnet out of the line and switching the other one in, the hands of the secondary clock being moved at the same time. The latter electromagnet is not, however, energised until its contacts have been released by the half-cylinder in the primary clock, when the two-way switch-lever is moved back again. Thus the battery is only in circuit for just the time sufficient for moving the armature in the secondary clock or clocks. C. K. F.

1010. *Cementation of Iron.* **G. Charpy.** (Comptes Rendus, 136, pp. 1000–1002, April 27, 1903.)—Experiments on the cementation of iron by means of graphite, wood charcoal, animal charcoal, coal gas, carbonic oxide, cyanogen, and potassium cyanide showed that the absorption of carbon is only limited by the solubility of carbon in iron, and that, apart from this, there is no saturation-point at which the iron ceases to absorb carbon. Carbide of iron, Fe_3C, containing 6·37 per cent. C, separates from the iron in crystals which

Digitized by Google

gradually increase in size ; if sufficient time be allowed, the iron becomes wholly converted by excess of carbon into this compound. In one experiment at 650° in contact with fused potassium cyanide, thin plates of soft steel had, after 48 hours' heating, 4·50 per cent. C ; after 86 hours and after 110 hours, 6·72 per cent. The velocity of diffusion increases with the temperature, but in massive ingots the rate of cementation is always slow. At higher temperatures the carbide is unstable, and decomposes into iron (martensite) and graphite ; prolonged cementation then leads to a continuous absorption of carbon and separation of graphite. A fragment of steel 8 mm. in diameter, was heated at 1,000° in a stream of coal gas during 64 hours, and gave a product containing 8·82 per cent. C, of which 7·66 per cent. was in the form of graphite ; a sheet of steel heated at 1,000° in carbonic oxide contained, after 86 hours, 9·27 per cent. C, of which 8·27 per cent. was in the form of graphite. T. M. L.

1011. *Strength of White-Iron Castings as Influenced by Heat-Treatment.* **A. E. Outerbridge.** (Frank. Inst., Journ. 155. pp. 289–300, April, 1903. Paper read at the fifth annual meeting of the American Society for Testing Materials, held at Atlantic City, June 12, 13, 14, 1902.)—By a process of reheating it is possible to convert white-iron castings into dense grey iron (density 7·80 as compared with 7·20 for normal grey iron) of high tensile strength, approximating to that of certain grades of steel, capable of being hardened and of taking a sharp cutting edge. The proportion of carbon is not altered, but it is changed from the combined to the free state. This process cannot be carried out with iron containing little silicon, as this seems to be essential for bringing about the separation of graphite. [See Abstract No. 118 (1902).] The white-iron castings are most easily made from iron containing little silicon, but in view of subsequent heat-treatment the best proportion is about 1 per cent. Si. The temperature at which the change takes place is about 1,000°. The process is in use for making hatchets and other edged tools, which are sometimes incorrectly described as steel, but is unsatisfactory unless care is taken to secure complete conversion. T. M. L.

1012. *Influence of the Rate of Cooling on the Structure of Steel.* **A. Sauveur** and **H. C. Boynton.** (Metallographist, 6. pp. 148–155, April, 1903. Paper presented to the American Institute of Mining, Albany meeting, Feb., 1903.)—The authors describe a preliminary investigation of the known difference between the apparent proportions of pearlite in two specimens of the same steel (in this case 0·52 per cent. carbon), both heated to 1,100° C., but one of them air-cooled and the other cooled with the furnace. The latter will show the true percentage of carbon by the ordinary mode of computation from the micro-structure, but the former would give much too high a value. The explanation offered is that the pearlite in the former is diluted with ferrite, as the cooling was too rapid for the usual segregation of ferrite to be complete, and is therefore not true pearlite, but sorbite in a somewhat late stage of its transitions. F. R.

1013. *Micrographic and Mechanical Study of Nickel Steel.* **L. Guillet.** (Soc. Franc. Phys., Séances, 2. pp. 72–95, 1903.)—The general results of the research have been already published. [See Abstract No. 1092 (1903).] The present paper contains reproductions of microphotographs of the nickel steels used in the experiments and details of the mechanical tests. The two

Digitized by Google

methods yield very concordant results, and it is possible to predict with considerable accuracy the mechanical properties of a given alloy from its appearance when examined under the microscope. It is therefore suggested that the microscopical examination may prove to be an industrial, as well as a scientific method of testing the metal. T. M. L.

REFERENCES.

1014. *Electrolytic Rectifiers.* **C. F. Burgess** and **C. Hambuechen.** (Amer. Electrochem. Soc., Proc. 1. pp. 147–161; Discussion, pp. 162–168, 1902.)—The authors describe a series of experiments illustrated by curves, and suggest directions in which further research is desirable. G. W. DE T.

1015. *Pumps and other Auxiliary Apparatus for Electrolytic Installations.* **D. H. Browne.** (Elektrochem. Zeitschr. 9. pp. 261–265, March, 1903. Also Amer. Electrochem. Soc., Proc. 2. pp. 219–232; Discussion, pp. 232–234, 1902.)—An illustrated account of various appliances, such as pumps, heating and evaporating vessels, mainly intended for use in conjunction with solutions containing nickel and copper chlorides, and some free chlorine, &c. The author gives an account of failures and also of successfully worked apparatus. O. J. S.

1016. *Uninterchangeable Fuses.* **R. Hundhausen.** (Elektrotechn. Zeitschr. 23. pp. 1070–1074, Dec. 4, 1902.)—This letter contains a criticism of some points in the different systems of fuses, uninterchangeable except with others for the same current, which have been put on the market by the Allgemeine Elektricitäts Gesellschaft, Siemens and Halske, and Mix and Genest, of Berlin, and discusses some of the rules of the Verband Deutscher Elektrotechniker bearing on this subject. J. B. H.

1017. *Electric Furnaces.* **E. R. Taylor.** (Amer. Electrochem. Soc., Proc. 2. pp. 185–188, 1902.)—The author describes and illustrates a furnace for prolonged and continuous use. G. W. DE T.

1018. *Testing Carbon Electrodes.* **F. A. J. Fitzgerald.** (Amer. Electrochem. Soc., Proc. 2. pp. 42–48; Discussion, pp. 48–50, 1902.)—The author describes apparatus and methods for density determinations, and for distinguishing between amorphous carbon and graphite. [See also Abstract No. 481 (1903).] G. W. DE T.

1019. *Iron Testing.* **G. Brion.** (Elektrotechn. Zeitschr. 24. pp. 177–179, March 5, 1903.)—The author describes certain improvements introduced by him into Richter's magnetic testing apparatus (Elektrotechn. Zeitschr. 23. p. 491). A. H.

1020. *Constitution of Steel.* **L. Guillet.** (Génie Civil, 42. pp. 369–371, April 4, and pp. 386–388, April 11, 1903.)—A review of the present state of our knowledge of the constitution of iron-carbon steels, with microphotographs of steels of different composition. T. M. L.

1021. *Structure of Defective Iron and Steel.* **S. A. Houghton.** (Metallographist, 5. pp. 256–285, Oct., 1902. From the Proceedings Institute of Marine Engineers, April, 1902.)—The paper is illustrated by a large number of microphotographs of specimens of iron and steel which have failed in various ways. The author, with the aid of these photographs, discusses the chemical and physical conditions leading to the failures. G. W. DE T.

Digitized by Google

GENERATORS, MOTORS, AND TRANSFORMERS.

1022. *The Double-Current Generators.* **P. M. Verhoeckx.** (Écl. Électr. 35. pp. 241–253, May 16, 1903.)—The theory of double-current generators includes the theory of rotary converters as a particular case, and the formulæ for the latter can be at once written down from the formulæ for the former. The author begins by making a careful analysis of the currents in the various windings of the armature of a double-current generator. He points out the importance of distinguishing between the time-lag λ and the phase-difference ϕ of the currents in the armature. If I be the effective value of the resultant current, and A and C the effective values of the alternating and what is commonly called the direct-current components respectively, then—

$$I^2 = A^2 + C^2 + 2AC \cos \phi,$$

and $\cos \phi = 0{\cdot}9 \cos \lambda$. The direct current in a winding is really an alternating current of rectangular shape. A simple relation is given connecting the direct-current power and the alternating-current power generated. The author calls this the general equation of the double-current generator. Interesting graphic illustrations of it are given. He also deduces from it a formula for the heating of the armature of a rotary converter. Steinmetz's formula is a particular case of this formula. A. R.

1023. *Parallel Working of Gas Engine-driven Alternators.* **E. Rosenberg.** (Elektrotechn. Zeitschr. 23. pp. 425–429, May 15; 450–454, May 22; and pp. 468–471, May 29, 1902. Paper read before the Hannoverscher Elektrotechniker Verein, Jan. 23, 1902.)—The author deals with the conditions necessary for the satisfactory parallel working of alternators, and starts from a general discussion on the mechanical problem of oscillations. There is still a certain feeling against the use of gas engines for driving alternators in parallel, on account of the great variation of speed, but the author points out that with the new type of Körting engines this variation can be as easily controlled as with steam engines. These gas engines, however, being of the double-stroke type, are practically available for large outputs only (say 400 h.p. and above), so that the problem of the ordinary gas engine with its comparative unsteadiness is still of interest. There is some uncertainty among experts as to the chief condition required for good parallel working. Friese (Zeitschr. d. Ver. Deutsch. Ing. p. 1181, 1899) simply asks for a variation of speed not exceeding $\frac{1}{2}$ per cent., whereas Kapp does not consider this variation to be of final importance. Görges (see Abstract No. 1360, 1900) adds a second condition of equal importance, namely, the number of impulses during one revolution. The author considers the oscillating energy, which must be balanced by the synchronising tendency of the alternator, to be dependent mainly on the amount of "lead" or "lag," *i.e.*, the maximum linear or angular difference between the actual and the mean rotation. For the maximum lead or lag a formula is given, determining this value in electrical degrees, viz., $\sigma_0 = \frac{k. \times 360 \times p}{2N \times 2\pi}$, where k denotes the variation of speed, N the number of impulses during one revolution, and p one-half the number of poles. A table is added showing some actual figures for both gas and steam engines. The author concludes that the satisfactory parallel

Digitized by Google

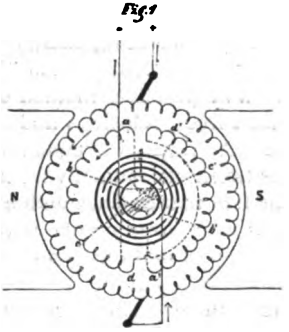
working depends mainly on the ratio between the primary impulse of oscillation and the synchronising energy due to the value of lead or lag. This ratio commands the convergence of a geometrical progression which corresponds with the decreasing oscillations. This progression must decrease quickly enough, so as to prevent the variation of speed due to the oscillations putting the governor into action. The author adds, further, that the governor is by no means fit to regulate quick periodical variations of speed, but, on the contrary, is likely to increase the oscillations. A rough example is given of the synchronising energy necessary to overcome a certain degree of lead or lag. Suppose the alternator works on an inductive load with a power-factor 0·8 ; assume, further, that the short-circuit current amounts to three times the normal full-load current, one finds that a synchronising energy equal to the normal full-load energy would be sufficient to balance a lead of 32° (electrical degrees). Hints are given for an easy and practical method of drawing a diagram, showing value and phase of the forces, velocities and accelerations connected with the oscillation problem. As regards irregular disturbances of the working conditions, *e.g.*, if load is taken off suddenly from one of the two alternators, attention is drawn to the fact that engines with a very steady tangential force (triple compound engines with three cranks under 120°) are more likely to fall out of step at such sudden alterations than engines where the tangential pressure is subject to considerable periodical variations. Even in extreme cases the heating effect of the synchronising currents is not likely to injure the windings, the temperature rise being equivalent to comparatively small overloads only. A detailed description of an extensive plant of gas-engine alternators (Julienhütte furnaces) concludes the paper, and special attention is drawn to the arrangement of the eddy current brakes, which have advantages also in the paralleling of the alternators. FR. B.

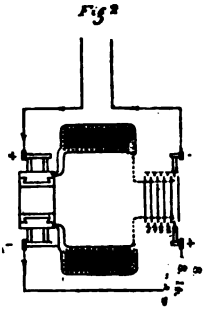
1024. *Parallel Running of Alternators.* **H. Görges.** (Elektrotechn. Zeitschr. 23. pp. 1053–1055, Dec. 4, 1902.)—Referring to a paper on this subject by Rosenberg, the author offers some criticisms, and points out that although the graphical method used by Rosenberg [see preceding Abstract] is very useful in enabling one to form a correct mental picture of the actions involved, the analytical method as developed by himself [see Abstract No. 1860 (1900)] is to be preferred for purposes of exact calculation. In considering the use of Leblanc's damping coils, the author states that although these damp both the natural and the forced vibrations, and thus prevent the machines from falling out of step, yet they are incapable of altogether preventing variations in the load, and if these latter exceed a certain limit, fluctuations in the p.d. will result. The surest way of securing good parallel running is to use very heavy flywheels. A. H.

1025. *Characteristic Curves of Traction Motors.* **Barbillion.** (Écl. Électr. 35. pp. 253–255, May 16, 1903.)—The author considers the case of a series motor. Having given the speed, torque, and efficiency curves all plotted out as functions of the armature current when there is no resistance in series with the armature, he shows how to find these characteristics for various values of the rheostat resistance in series with the armature. The speed characteristics follow directly from the ordinary equations, the torque characteristics are all given by the same curve, and he finds the efficiency characteristics by assuming that the friction losses are proportional to the speed, the eddy losses to the square of the speed, and the hysteresis losses to the speed and the 1·6 the power of the mean density of the magnetic flux. A. R.

Digitized by Google

1026. *Variable Speed Shunt Motors.* **F. Müller.** (Elekt. Runds. 20. pp. 132–133, April 1, 1903.)—This article is devoted to a description of an arrangement which consists in supplying the armature with an auxiliary winding connected to a number of collector rings, all but one of which are in two insulated halves as diagrammatically illustrated in Figs. 1 and 2. This auxiliary winding is placed in the same slots as the main winding. The collector ring brushes are capable of longitudinal movement, so that they can at will be made to bear upon any one of the collector rings. In the position shown in Fig. 2, in which they bear upon the right-hand ring, the lowest





speed is obtained, since, as will be seen by tracing through the connections in Fig. 1, the current on its way to the commutator flows in opposition to the e.m.f. of the whole of the auxiliary winding. When the brushes are shifted to the second collector ring, the counter e.m.f. of but two-thirds of the auxiliary winding is interposed. Finally, for full speed, the brushes are moved to the last collector ring (numbered 5 and at the left-hand end of the collector), and this ring being undivided, and not connected to the auxiliary winding, the motor operates as an ordinary shunt motor. H. M. H.

1027. *Regulation of Speed of Induction Motors.* **G. Winter.** (Zeitschr. Elektrotechn., Wien, 21. pp. 213–215; Discussion, p. 215, April 12, 1903. Report read before the Elektrotechn. Verein at Vienna, Jan. 22, 1903.)—In ordinary induction motors a regulation of the speed is generally obtained by inserting resistances in series with the phases of the rotor. But this is very undesirable, as it so greatly impairs the efficiency. The problem to be solved is to make the energy which is wasted as C^2R loss in the resistances useful by sending it back to the supply mains. As the currents in the rotor have a periodicity proportional to the slip, and thus far smaller periodicity than that of the supply current, the author used a commutator in connection with the rotor, with a view to transforming the currents of low periodicity into currents of the original primary periodicity. By means of a stationary transformer it was then possible to send the whole of that energy which would otherwise be wasted as C^2R loss in the resistances, back to the mains. By varying the position of the brushes, or by varying the ratio of the stationary transformer, or both, the motor may be made to run at any desired speed up to and even above synchronism. The author gives curves showing the input in kilovoltamperes, plotted against speed and torque, of a 12½-h.p. motor, built after the instructions of the inventors, Winter and Eichberg. In the discussion following the report the author states that, with carbon brushes, the motor runs sparkless at all speeds. H. M. H.

Digitized by Google

ELECTRICAL DISTRIBUTION, TRACTION AND LIGHTING.

ELECTRICAL DISTRIBUTION.

1028. *Motive Power from Central Supply Stations.* **R. A. Chattock.** (Inst. Elect. Engin., Journ. 32. pp. 621–624; Discussion, pp. 624–630, May, 1903.)—A short paper describing the methods adopted to increase the use of electricity for power purposes in Bradford, and the progress made since 1891. Low charges and a system of hiring out motors, have produced striking results. On December 31, 1902, a total of 913 motors were connected to the mains, and of these, 614 were on hire from the Corporation. The total units sold for power purposes in 1902 were estimated to be 1,899,878, and the average price obtained was 1·17d. per unit. A useful discussion followed the reading of this paper. J. B. C. K.

1029. *Droop and Tension in Wires.* **H. v. Glinski.** (Elektrotechn. Zeitschr. 24. pp. 255–256, April 2, 1903.)—This is a paper of a mathematical nature, in which the author gives formulæ for calculating the droop and the stretching force approximately, and considers also more accurate graphical methods. Practical numerical examples are given. W. S.

1030. *Specifications for Proposed Standard Insulator Pin.* **R. D. Mershon.** (Amer. Inst. Elect. Engin., Trans. 20. pp. 415–419; Discussion, pp. 445–498 and 521–534, April, 1903.)—The dimensions of this pin (wood) are calculated so as to obtain a uniform strength throughout its length. A lettered diagram and a table of dimensions are given for pins having shanks varying from 5 to 19 in. long. In the discussion the majority of the speakers preferred iron pins to wood. C. K. F.

1031. *Insulators on High-Tension Transmission Lines.* **C. C. Chesney.** (Amer. Inst. Elect. Engin., Trans. 20. pp. 435–442; Discussion, pp. 445–498 and 521–534, April, 1903.)—Some notes on facts connected with the burning of a number of wooden insulator pins on high-voltage transmission lines. These pins are usually made of locust, oak, or eucalyptus wood, and serve well under ordinary conditions up to potentials as high as 25,000 volts. The author examines several cases of failure, and considers that iron pins are likely to be more suitable if used with good insulators. W. H. S.

1032. *Power Transmission by Alternating Currents.* **E. Walch.** (Assoc. Ing. Él. Liége, Bull. 8. pp. 109–159, March–April, 1903.)—In the first part of the paper the methods of calculating the electrical constants for single-phase, two-phase, and three-phase overhead transmission lines are given. Full particulars and calculations are given for the overhead work of a power-station in France which transmits 1,000 h.p. a distance of 75 km. by means of three-phase currents, the pressure between the lines being 20,000 volts. The formulæ used for calculating the mechanical stresses on the insulators and the sag of the wires, &c., are given. Useful methods for testing insulators for use with very high voltages are described. A. R.

Digitized by Google

1033. *Influence of Substation Equipment and Transmission Line on the Cost of Electricity Supply.* **A. Stewart.** (Inst. Elect. Engin., Journ. 31. pp. 1122-1140; Discussion, pp. 1141–1145, June, 1902.)—Various curves are given showing (1) the relative costs of copper and insulation in cables for various voltages; (2) the approximate weight of copper required to transmit 1,000 kw. to a distance of 10 miles, with 10 per cent. loss at full load, with e.m.f.'s of 7,000, 10,000, 15,000, and 20,000 volts between the three-phase lines, at power-factors varying from unity to 0·5; (3 and 4) the relative costs of copper, insulation, and total cost, under the conditions named in (2). The point brought out by these curves is that the cost of copper varies inversely, and the insulation directly, as the square of the e.m.f. In considering sub-station equipment detailed tables of costs are given for equipments—(1) with synchronous motor-generators; (2) induction motor-generators; (3) rotary converters, all at 15,000 volts, with 3 three-core transmission cables, including one spare. Table (4) synchronous motor-generators, with three cables; (5) six-phase rotary converters, with six overhead bare lines. In each case the line voltage is 15,000, and in all except (5) a drawing-in system with cast-iron pipes is assumed. The price of energy delivered to the low-tension bus-bars is then worked out for each of the above cases. The cost per kw. installed works out in Table 1 as follows: Generating station, £25; line, £15·7; substation, £6·5. The cost per kw. of maximum demand, which is the figure determining the commercial success of the system, is: Generating station, £20·8; line, £26·2, and substation £10·7. F. B.

1034. *Equalisation of Fluctuating Loads in Power Transmission Plants.* **G. Meyersberg.** (Elektrotechn. Zeitschr. 24. pp. 261–265; Discussion, pp. 265–269, April 2, 1903. Report read before the Elektrotechn. Verein, Jan. 28, 1903.)—The article is chiefly devoted to a discussion of the use of a flywheel directly coupled to a dynamo operating during the light loads on neighbouring apparatus, from the circuit as motor, and storing up energy in the flywheel which drives the dynamo as generator to assist in carrying the peaks of the load. Such a device is more or less the equivalent of a buffer battery, and is by the author designated a buffer-machine. The writer states that, whereas with cast-iron flywheels the peripheral speed is limited to about 50 m. per sec., the use of cast steel permits of exceeding 100 m. per sec., and thus of obtaining far greater storage capacity from a flywheel of given proportions. He has operated, at a peripheral speed of 85 m. per sec., flywheels built of rolled sheet steel plates riveted together. It is mentioned that in steam turbine constructions the use of nickel steel has enabled peripheral speeds of over 400 m. per sec. to be attained, but it is pointed out that such high peripheral speeds could not be employed for the flywheels of buffer-machines, since, unlike the steam turbine's rotor, the buffer-machine's flywheel has its centre of gravity near the rim.

The principle has, it is stated, been applied in three ways: first, as proposed by Kapp in 1893 (Minutes of Proceedings of the Inst. of Civil Engineers, vol. 112, 1893, p. 282) by having a machine directly coupled to a flywheel located at the part of the line which it is desired to reinforce. When, on suddenly increasing loads, the voltage drops, the machine changes from motor to generator in virtue of the stored-up energy in its flywheel. This was carried into practice at Brockton, Mass., in 1898 (Elec. World, 1898, p. 489). The second method is that devised by the writer, and differs in principle from Kapp's method chiefly in making the buffer-machine responsive directly to changes in the *current* required by the load instead of to the

Digitized by Google

resulting *voltage* variation. This is effected by a series field winding, and to prevent the attainment of too high a speed at light load it is suggested that a centrifugal governor may, at a given speed, switch on an auxiliary shunt winding, or this shunt winding may remain permanently in circuit. The third (the Ilgner) system mentioned by the writer depends upon *speed* variations, instead of upon variations in *voltage* or *current*. By this system an induction motor is directly coupled to a continuous-current dynamo wbich carries the load of motor or motors. The motor-generator set carries a flywheel of suitable capacity, and when the load increases suddenly the slip of the induction motor tends to increase, and the stored-up energy of the flywheel assists it in carrying the load. As the slip of an induction motor is so slight, this would require a flywheel of large capacity, hence a centrifugal device is added, arranged to automatically increase the resistance of the induction motor's secondary circuit with decreasing speed, thus increasing the slip by some 10 per cent. to 12 per cent., and, for a given fluctuation in load, decreasing the size of flywheel required. When the Ilgner system is employed for operating a single large hoist, the speed of the motor operating the hoist is regulated by adjusting the excitation of the generator of the motor-generator set substantially in accordance with the Ward-Leonard systems. It is, in fact, chiefly for the operation of such hoists in mines that the Meyersberg, as well as the Ilgner system, have been devised. A long and very instructive discussion followed the paper, supporters of the two rival systems participating. H. M. H.

1035. *Model showing Distribution of E.M.F. and Current along a Single-phase Transmission Line.* **W. S. Franklin.** (Amer. Inst. Elect. Engin., Trans. 20. pp. 443–444; Discussion, pp. 445–493 and 521–584, April, 1903.)—A model was exhibited at a meeting of the Institution, and consisted of specially constructed helices, which when rotated were intended to represent the e.m.f. along a transmission line, taking into account the leakage, resistance, reactance, &c. W. H. S.

ELECTRICITY WORKS AND TRACTION SYSTEMS.

1036. *Worcester New Electricity Works.* (Electrician, 51. pp. 197–200, May 22, 1903.)—System: Three-wire direct-current at 2 × 230 volts. The engine-room contains three 250-kw. Bruce-Peebles generating sets, driven by Belliss engines, and a 75-kw. motor-alternator which can be coupled to a steam engine. One of the large sets consists of two 125-kw. dynamos which serve as balancers. The motor-alternator enables the new works to run in parallel with the existing alternating-current station. A battery of 630 ampere-hours' capacity is provided, with a charging booster. The boiler-house contains three Babcock boilers fitted with chain-grate stokers, and capable of evaporating 11,000 lbs. of water per hour each, and there is an economiser of 288 tubes. Each engine is provided with a separate condenser. Triple concentric lead-covered feeders are used, laid on the solid system, and connected with the mains formerly used for the low pressure alternating-current supply. The tramways are supplied with energy at from 2d. to 1½d. per unit, according to the quantity used. The article is illustrated. A. H. A.

1037. *Lake Copais Power System.* (Elect. Rev. 52. pp. 785–787, May 8, 1903.)—This is mainly a pumping station used for the drainage of Lake Copais, the power being obtained from a fall on the river Melas, at a distance

Digitized by Google

of about 8 miles. Two Francis horizontal turbines, designed for a head of 7 to 8 m., and duplexed to give a common discharge and eliminate thrust from the water pressure, drive directly two 180-kw. 5,000-volt, three-phase revolving-field Ganz generators running at 210 r.p.m., and a four-pole exciter carried on an extension of the main shaft. The pumping station contains two 80-b.h.p. 5,000-volt induction motors, running at 490 r.p.m. The switches are of the ordinary three-pole quick-break horn type, and the fuses are carried in weighted fibre tubes encased in massive ebonite handles. The line loss, with both pumps working, is 6·8 per cent. G. W. DE T.

1038. *Richmond (U.S.A.) Light and Power Plant.* **J. B. Nelson.** (Eng. News, 49. pp. 99–100, Jan. 29, 1903. Abstract of a paper read at the annual meeting of the Indiana Engineering Society, at Indianapolis, Jan. 15.)—This is a small station containing a 450-kw., and a 300-kw., three-phase, 60-cycle, 2,300-volt revolving-field, steam-driven generators. G. W. DE T.

1039. *Aberdeen New Electricity Works.* (Elect. Engin. 31. pp. 654–662, May 8, 1903.)—The generating plant in the new works comprises two dynamos of 420 kw. each, and three of 200 kw. each, all driven by Willans compound engines. There are also a 60-kw. balancer, and two 42-kw. boosters driven by one motor. Separate condensing plant is provided for each engine. The boiler-house contains six Babcock boilers, with superheaters and chain-grate stokers, each boiler being capable of evaporating 15,000 lbs. of water per hour. There are two economisers of 480 tubes each. Two storage batteries are installed, capable of giving 2,200 amperes at 220 volts. A subway 2,480 ft. long has been constructed to accommodate the main cables. The total output for the year ending March 18, 1903, was over two million Board of Trade units. The price charged for lighting is 6d. and 2½d. on the maximum demand system, 3d. and 1d. for power, and 2d. for traction. The article is well illustrated. A. H. A.

1040. *Albuquerque Gas, Electric Light and Power Company.* **J. H. Rusby.** (Elect. Rev. N.Y. 42. pp. 682–683, May 16, 1903.)—The boiler outfit consists of two 200-h.p. marine type Springfield boilers, heated by slack coal. An additional boiler of the same type is now being installed for an extension of power capacity. An 80-h.p. return tubular boiler is fitted to receive the exhaust gases of the furnaces, to heat the boiler water, and to act as a precipitator to extract the impurities from the water before using. The engine equipment consists of one 150-h.p. Ideal horizontal automatic spring-governed engine, one 110-h.p., and two 80-h.p. Armington and Sims horizontal automatic spring-governed engines; and an additional 500-h.p. Allis-Chalmers cross-compound Corliss engine will be installed as part of the extension. This latter engine will be direct-coupled to a 333-kw., 60- ∿ , 2,300-volt G.E. generator. The present equipment of generators consist of two 80-kw. and two 20-kw. Edison direct-current 125-volt generators, and one 100-kw. and one 75-kw. G.E. three-phase, 60- ∿ , 2,300-volt generators, together with one 60-kw. G.E. single-phase, 2,300-volt alternator. The 100-kw. alternator is separately excited by a 125-volt direct-current generator, and the other alternators by current from the Edison direct-current machines, the exciting current being controlled by separate rheostats. With the exception of the Allis-Chalmers G.E. unit, these machines are belt-connected to the driving engines. G. W. DE T.

Digitized by Google

1041. *Electric Lighting of the Aldershot Camps.* (Electrician, 51. pp. 152–154, May 15, 1903.)—This installation includes three 250-kw. generators, driven by Parsons turbines, and six Babcock boilers, together with a battery of accumulators of 40-kw. capacity. W. H. S.

1042. *Electricity in French Slate Quarries.* (Engineering, 75. pp. 675–676, May 22, 1903.)—The first part of the paper deals with the methods of mining employed. The small works lacking capital, mine by open working, or by vaults under the slate, underhand stoping being used in both cases. The newest Works employ galleries from shafts, working upwards, and filling the stalls with waste. The Société Ardoisière de l'Anjou have complete electrical installations, fully described in the paper, and, briefly, comprising three boilers, a 150-h.p. condensing de Laval steam turbine driving two three-phase alternators working at 110 to 120 volts, at 52 ∿. Regulating transformers, exciter, &c., are described, also the distribution circuit. A diagram of the connections is included. J. L. F. V.

1043. *Electric Installation at the Prince Regent Theatre, Munich.* **C. Arldt.** (Elektrotechn. Zeitschr. 24. pp. 249–255, April 2, 1903.)—The theatre is supplied with 5,000-volt three-phase current at 100 ∿, which is transformed to 250-volt direct current by means of two rotary transformers, each of 125 kw. A 2 × 132-cell Hagen accumulator-battery of 855 kw.-hours' capacity is also provided. The floats, battens, &c., are provided with four sets of lamps having white, red, green, and yellow bulbs, which can be controlled by special automatically operated rheostats to obtain the various light-effects required on the stage. There are in all 3,438 incandescent, and 42 arc-lamps. The original paper contains a complete diagram of the stage circuits and a large number of photographs and drawings of the apparatus used. C. K. F.

1044. *Electric Installation at the Draeger Printing Works.* **J. Reyval.** (Écl. Électr. 34. pp. 5–12, Jan. 3, 1903.)—The power distribution is arranged on the four-wire system, and current is available at pressures of 120, 170 and 220 volts. The main generators give 120 volts, and the increased pressures are obtained by means of boosters. W. H. S.

1045. *Private Installation in Berlin.* **E. Josse.** (Zeitschr. Vereines Deutsch. Ing. 47. pp. 869–876, March 14, and pp. 480–485, April 4, 1903.)—The author describes a station, designed by himself, which has been erected in a business house in the centre of Berlin. Considerations of space were the governing factor in the design. The boiler-house is on the top floor, and the engine-room in the basement. The boiler gases are removed by a system of induced draught, worked by Sturtevant fans; the draught in the chimney can be varied between 25 mm. and 65 mm. of water pressure. The chimney originally extended to a height of 6 ft. above the boiler-house roof; but owing to nuisance caused, it has since been raised to a height of 40 ft. It cost about half the amount a chimney would have required, and as the latter would have had to be brought up through five floors, the saving in foundations and floor space was considerable. W. H. S.

1046. *Economy of Small Isolated Factory Lighting Plants.* **F. O. Runyon.** (Elect. Rev. N.Y. 42. p. 675, May 16, 1903.)—The author has found that in many

Digitized by Google

cases of small factories using from 100 to 200 h.p. for machine driving, the replacement of the existing system by electric driving would not be of advantage, but, nevertheless, an economy could be effected by installing a lighting plant run from a generator driven by the surplus steam power. Figures are given based on his experience. G. W. DE T.

1047. *Electric Railway in Paris.* **C. L. Durand.** (Elect. Rev. N.Y. 42. pp. 510–513, April 11, 1903.)—The Orleans Railway Company has found it necessary to construct a new terminus in the centre of the city, and operates the section connecting this with the old terminus by electricity. In consequence of the success attained, a four-track suburban road, 15 miles long, is to be converted. The present section is 2·8 miles long, of standard gauge double track, with several underground stations, and is operated with a third-rail by direct-current at 550 volts, using electric locomotives. The power is generated at 5,500 volts three-phase, 25 ∿, and is transmitted to two rotary converter substations at the termini. The power-station contains eight Babcock and Wilcox boilers, having 1,980 sq. ft. heating surface each, and a Green economiser of 4,500 sq. ft. Water for condensing is derived from the river Seine by means of centrifugal pumps driven by induction motors. There are two Dujardin triple-expansion, four-cylinder, two-crank horizontal engines of 1,500 h.p., each driving direct a 1,000-kw. alternator at 75 r.p.m.; the cylinders are 24·4, 37, and two of 42 in. diameter, with a stroke of 66 in. The alternators are of the General Electric (U.S.) Company's make, with revolving field magnets having 40 poles. There are two exciters driven by vertical engines, and two motor-driven lighting dynamos. Each substation is fed by underground cables of 3 × 75 sq. mm. cross-section, 2·1 and 4·8 miles long respectively, in duplicate, and contains two 250-kw. rotary converters with transformers for traction, two 100-kw. motor-generators for lighting, and two balancers, the lighting being carried out on the 5-wire system. There is also in each substation a battery of 1,100-amperes' capacity for one hour, which is used alternatively for traction and lighting. The locomotives weigh 50 tons each, and are equipped with four 125-kw. motors driving through single reduction gear, and controlled on the series-parallel system. Besides a rail outside the track, current is collected on occasion from a central rail and from an overhead conductor. The new system has been highly successful.

A. H. A.

ELECTRIC TRACTION AND AUTOMOBILISM.[1]

1048. *Electric Haulage on the Miami and Erie Canal.* (Street Rly. Rev. 13. pp. 121–126, March, 1903.)—This canal has been supplied with electric motive power for a distance of 68 miles between Cincinnati and Dayton. An ordinary tramway track runs along the towpath, and the power is supplied from overhead trolley wires on the three-phase system to a locomotive. The maximum speed is 6 miles an hour. A further account appears in the Street Rly. Journ. 22. pp. 830–841, Nov. 7, 1903. W. H. S.

1049. *Lorain Surface Contact System.* (Electrician, 51. pp. 44–47, April 24, 1903.)—This is an Abstract of a report submitted by **C. E. C. Shawfield,** Borough Electrical Tramways Engineer to the Wolverhampton Corporation,

[1] Non-electrical Automobiles are described in the Section dealing with Steam and Gas Engines.

Digitized by Google

on the surface contact tramways running in Wolverhampton. [See also Abstract No. 610 (1902).]

1. *Safety to Human Beings and Animals.*—In the following table are given the pressures between earth and contacts which should be "dead":—

Month.	Cups Damaged in Fixing.		Cups Damaged by Short-circuit.		Leakage due to Moisture in Granite Box.		Total.	
	10 to 49 Volts.	50 to 500 Volts.	10 to 49 Volts.	50 to 500 Volts.	10 to 49 Volts.	50 to 500 Volts.	10 to 49 Volts.	50 to 500 Volts.
1902.								
May	5	44	12	4	—	—	17	48
June	—	—	18	16	—	—	18	16
July	—	—	10	4	2	—	12	4
August	—	—	8	1	1	—	9	4
September...	—	—	5	4	2	—	7	1
October.....	—	—	8	10	—	1	8	11
November...	—	—	7	4	—	—	7	4
December...	—	—	7	8	—	—	7	8
1903.								
January.....	—	—	8	13	—	—	8	13
February ...	—	—	2	5	1	—	8	5

2. *Reliability.*—Information on this point will be found in the following table:—

Month.	Miles of Single Track in Operation.	Total Car-miles Run.	Car-miles per Mile of Single Track.	Total Car-miles Lost from all Causes.	Car-miles Lost due to Faults in Lorain System.			
					Lorain Car Equipment.	Lorain Track Equipment.	Total.	Total per Mile of Single Track.
1902.								
May	5·173	16,062	3,104	164	93	9	102	19·7
June	8·377	24,268	2,897	183	49	10	59	7·0
July	8·377	30,257	3,612	267	117	None	117	14·0
August	9·777	39,154	4,004	196	55	None	55	5·6
September	11·083	41,920	3,782	124	68	13	81	7·3
October	11·083	46,544	4,199	123	39	10	49	4·4
November	11·083	41,189	3,712	88	7	11	18	1·6
December	11·083	45,268	4,084	71	47	7	54	4·8
1903.								
January	11·083	48,502	4,376	137	85	6	91	8·2
February.....	11·083	43,486	3,923	130	35	19	54	4·8
Totals.....	—	376,600	—	1,483	595	85	680	—

A careful inspection of the table shows that out of a total of 680 miles lost due to breakdowns in the Lorain system, only 12½ per cent. were due to track

Digitized by Google

equipment, the remaining 87½ per cent. being accounted for by the car equipment.

8. *Consumption of Electrical Energy per Car-mile.*—The consumption of electrical energy per car-mile is greater with the Lorain system than would be the case with the overhead system. The causes are three: (1) The additional current required for the excitation of the magnetic skates. (2) The additional current required to propel the cars, owing to the extra weight of the magnet and battery equipment carried by each car. (3) The leakage which takes place over the surface of the street from box to rail under each car in service. The amount of current used per car-mile under each of the above headings is as follows: (1) Excitation of magnets, 0·111 units per car-mile; (2) extra weight of Lorain car equipment, 0·131; (3) leakage current, 0·008; making a total of 0·25 units per car-mile. The total average current consumption per car-mile with the Lorain system under normal conditions of traffic is about 1·4 units per car-mile. Deducting the figure of 0·25 units per car-mile as calculated above, it will be seen that the corresponding current consumption with the overhead system would be 1·15 units per car-mile.

In the following table the figures as to the annual maintenance of overhead equipment represent the average cost of repairs and upkeep in the case of fifteen towns, concerning which the author obtained information :—

COMPARATIVE COSTS OF MAINTENANCE.

Lorain System.	Cost in Pence per Car-mile.			Overhead System.	Cost in Pence per Car-mile.		
	A.	B.	Total.		A.	B.	Total
Track Equipment.				*Overhead Equipment.*			
Armature cup and contact mechanism	0·036	0·164					
Contact plates	0·094						
Inspection and testing of track	0·035			All overhead work	0·216	0·100	
[1] Renewals of granite casings		0·24					
Totals	0·165	0·404	0·569	Totals	0·216	0·100	0·316
Car Equipment.				*Car Equipment.*			
Magnet coils and cases	0·016	0·073		Trolley standards and poles	0·027	0·016	
Batteries and charging	0·005	0·022		Trolley wheels	0·010		
Collecting skates	0·06			Inspection and adjustment	0·027		
Inspection and adjustment	0·054						
Totals	0·135	0·095	0·230	Totals	0·064	0·016	0·080
Total Maintenance	0·300	0·499	0·799	Total maintenance	0·280	0·116	0·396
Electrical energy (1·4 units at 1·65d. per unit)			2·31	Electrical energy (1·15 units at 1·65d. per unit)			1·90
Total			3·109	Total			2·296

[1] As per Borough Surveyor's estimate. If the new form of granite casings with the improved top plates covering the casings are used, this item would be entirely or largely eliminated (see Borough Engineer's Report).

F. B.

1050. *Electric Track Welding.* **W. Fawcett.** (Scientific American, 88. p. 242, April 4, 1908.)—The author describes recent improvements in the Thomson process of track welding which have reduced the breakage percentage from 1 per cent. to one-tenth of 1 per cent. The welding apparatus proper consists of an alternating current transformer, the primary winding of which is made up of two coils in parallel, each of forty-four turns. A single

Digitized by Google

loop of copper of large cross-section forms the secondary coil; and the terminals constitute the contacts or jaws, which engage each side of the rail, and between which the weld is made. Supporting the transformer on either side, although insulated from it, are large levers hinged together at about two-thirds of the distance from the top, which levers are used to transmit the necessary pressure to the weld. A hydraulic jack connects these levers at the top. A pressure of over 2 tons per sq. in. is obtained on the rams of the jack, which are less than 4 in. in diameter; and inasmuch as this is increased by the leverage of the arms, the pressure developed at the weld is in excess of 87 tons. For making a joint, there are employed flat-rolled steel bars which have, on one side, at either end, bosses or projections, serving as contact points between the bars and the web of the rail, and confining the welded area of these sections. About the middle of the bars, on the same side with the projections, is placed a flat strip of steel, about ¼ in. in thickness and 1 in. wide. The bars are supported on small blocks, and so placed across the joint that the middle strip engages the web of both rails. The end welds are horizontal, while the middle weld is vertical, and the full width of the bar. To make a joint, the ends of the rails are first subjected to the action of a sandblast. The welding train of two cars is then moved up to the joint; the welder is swung into place, and the jaws made to press against the bars on each side of the rail. The current is then turned on, and flows from contact to contact through the bars and the rail web. By altering the pressure on the jaws, the resistance of the several junctions is increased, and the whole is soon brought up to a welding heat. When this point is reached, the current is cut off, and, simultaneously, the pressure is brought up to the full amount. After the pressure is removed, the welder car is moved back, in order to bring the jaws opposite the extremity of the bars, and here the same process is repeated, with the addition that when the final pressure is applied, it is held there, and the weld permitted to cool under pressure, until no glow is apparent. Then the welder is moved forward to the other end of the bar, and the process is repeated, after which the welder is swung to the opposite side of the car and the joint on the other side is welded. The present plan of holding the pressure after the completion of the weld increases the strength of the weld very materially. Only the ends are so treated, the centre weld being subjected to so slight a strain that such a precaution is unnecessary. One of the improved processes of the new plan of welding grows out of the discovery that it is advantageous to weld the ends of the bars while the bars are in an expanded state. By making the centre weld first, and not stopping to cool it under pressure, the greatest elongation of the bars is, of course, secured. As the bars cool off, after the ends are welded, they shrink, and exert a powerful pull to bring together the abutting rail-ends, thus closing the slightest opening, and leaving practically no joint whatever. This is important, for in the manufacture of a continuous rail, the abutting rail-ends, if not brought firmly together, give the metal in the head of the rail an opportunity to flow into the opening between the rails. This will in time cause a low spot in the head of the rail. The bars being always in a state of tension, the rail enclosed between the bars is necessarily in a state of compression; and inasmuch as any contraction of the rail between the joints will be transmitted to the end welds, it is obviously necessary that these latter should be as tough as possible, that they may withstand the strain. The centre weld merely contributes to vertical stiffness, and tends to prevent any movement of the rail-ends. The current used varies from 25,000 to 30,000 amperes at 7 volts. The car accompanying

Digitized by Google

the welder carries a rotary converter for changing the direct current from the trolley to an alternating current. The current in the primary coils of the welder is 40-cycle alternating, at 300 volts; and the direct-current side of the rotary converter is capable of taking current from the trolley at from 325 to 600 volts. By means of the regulating apparatus, a constant supply to the welder of 300 volts is maintained, regardless of fluctuations on the line. At a voltage of 500, about 225 amperes is required on a line, or, in other words, about 125 kilowatts is required to make a weld, the time consumed, or rather the interval during which the current is on, being two and a half minutes. The final operation of welding consists in grinding the head of the rail to a true surface; with new rails this is unnecessary. G. W. DE T.

1051. *Traction Resistance of Small Mine Cars.* (Eng. News, 49. p. 57, Jan. 15, 1903.)—The paper gives the results of a number of tests which show that the 20-lb. resistance per ton of mine-car load usually allowed is too low by from 1½ to 2½ times. On a fairly level, moderately dirty track it may be taken at 40 lbs. This large comparative resistance of small cars may be attributed partly to the smaller wheels giving less leverage to overcome axle friction, partly to the light wheel loads, and partly to the imperfect ballasting of mine tracks. The tests show that the resistance per ton of a train of 20 cars is not much more than a third of that of a single car. This is probably largely due to the track being cleaned to a considerable extent by the leading car. Also in ordinary so-called level mine track there are numerous waves forming up and down grades; and in a long train, some trucks are coasting down and pushing up the ascending ones, thus reducing the draw-bar pull.

G. W. DE T.

1052. *Waverley Electromobiles.* (Automotor Journ. 8. pp. 419–426, April 25, 1903.)—A very fully illustrated description of these cars. In the light run-about, with single motor, the battery is a 24-cell Exide, each cell containing 9 plates, and rated at 110 ampere-hours' capacity at a 30-ampere discharge rate. In the double motor equipment, 40 cells of the same size are used, and the motors are also of the same size as in the smaller cars. The motor is placed just in front of the rear axle, being bolted by a flanged coupling to the casing of the differential gear. The motor is capable of giving a normal output of 8 h.p., and the double helical driving pinion is completely enclosed in the differential casing. In the double-motor equipment the differential gear is dispensed with, each motor driving its own independent large gear-wheel on the live-axle. A full description of the controller is given, and a diagram of connections, showing how the change of speed and electrical braking are effected. L. H. W.

1053. *Railway Block Signalling.* **J. Pigg.** (Inst. Elect. Engin., Journ. 32. pp. 601–618; Discussion, pp. 618–620, May, 1903.)—A review of present methods and possible improvements. In regard to the latter, the following may be noticed: In this country there is already an installation of automatic signalling in operation between Grately and Andover, on the London and South-Western Railway, in which the signals are actuated by air on the low-pressure system, the movements being controlled by the positions of trains on the line, which is formed into track circuits. The North-Eastern Railway Company has also made arrangements with the Hall Signal Company of America to equip a portion of their main line to the North, between Alne and

Digitized by Google

Thirsk, with a track circuit system of automatic operation. This installation will differ from the ordinary Hall system—in which the signals are operated by electric motors—and from the London and South-Western Company's installation, in that the signals will be self-contained as regards motive power. Movements will be made by carbonic acid contained in steel cylinders at a pressure of 600 lbs. per sq. in., the working pressure being 50 lbs. As many as 10,000 movements can be obtained before it becomes necessary to recharge. At the junctions between Alne and Thirsk the automatic signals leading to fouling points with the branch lines will also be under manual control, so as to admit of branch working. Such cabins, however, will be closed at times when the branch traffic ceases. The sections will be shorter than ordinary. Siding points connecting with the main line in the purely automatic sections will be provided with indicators communicating with several of the rear sections to show whether trains are approaching before the switches are opened for the siding. E. O. W.

ELECTRIC LAMPS AND LIGHTING.

1054. *The Nernst Lamp.* **O. Bussmann.** (Elektrotechn. Zeitschr. 24. pp. 281–284; Discussion, pp. 284–285, April 9, 1903. Paper read before the Elektrotechn. Verein, Feb. 24, 1903.)—The author gives a short account of the development and present state of the Nernst lamp. Filaments to carry ½ ampere at 200 volts are 20 mm. long and 0·4 mm. in diameter; those for 1 ampere at 200 volts are 80 mm. long and 1 mm. in diameter. Filaments to carry less than 0·2 or more than 1·5 amperes cannot at present be made satisfactorily. The following table refers to tests carried out by the Reichsanstalt, and similar figures are also given of tests carried out by Wedding.

REICHSANSTALT TESTS ON NERNST LAMPS.

Hours of Running.	6 Lamps for 1 ampere at 220 volts.		6 Lamps for ½ ampere at 220 volts.	
	Hefner c.p.	Watts per Hefner c.p.	Hefner c.p.	Watts per Hefner c.p.
0	158·2	1·54	40·1	1·42
50	137·2	1·66	36·8	1·57
100	137·8	1·67	38·1	1·49
200	137·8	1·65	34·1	1·59
300	138·8	1·57	33·2	1·58
400	—	—	27·6	1·75
Mean	139·1	1·68	34·5	1·57
Mean Life	286 hours		291 hours	
Reduction factor for spherical c.p.	0·78		0·64	

W. H. S.

1055. *New Electric Lighthouse Plant at Heligoland.* **O. Krell, Jr.** (Elektrotechn. Zeitschr. 24. pp. 287–292, April 16, 1903.)—In this lighthouse there are three projector-lanterns mounted on a rotary frame with their axes 120° apart and having silvered-glass parabolic reflectors, each of 75 cm. diameter and 250 mm. focal length; no glass covers are used for the projector-casings. This frame turns on ball-bearings, the weight being partly taken by an annular float arranged in a mercury bath. It is rotated four times per minute by means

Digitized by Google

of an electric motor driving through worm and spur gearing. The pinion of the spur gearing is made of raw-hide and is secured by a friction-coupling to the worm-wheel shaft, so as to enable it to be turned by the inertia of the rotary frame after the motor and worm-gear have stopped. In order to provide against a breakdown of the above, a fourth projector of similar specification is arranged above the three just described; this is, however, rotated at three times the speed, since there is only one-third the number of beams of light. The carbons of the Schuckert shunt arc-lamps are arranged along the axes of the reflectors, the 9·7 mm. craters of the positive carbons being turned towards the reflectors. Each lamp gives a ray of 2° 14″ divergence, having a mean intensity of 84·1 million Hefner candles measured at a distance of 1,290 m., using a current of 26 amperes at 45 volts. The three projectors are 82 m., and the one reserve projector 88·2 m. above mean high-water mark, the beams being visible at 28 nautical miles distance. There are two steam dynamos each of 216 amperes and 65 to 75 volts, one being used as a reserve. They serve for other lighting purposes in addition to supplying the projector-lamps. The original paper is very fully illustrated. C. K. F.

1056. *Electric Lighting of Trains.* **J. F. McElroy.** (Amer. Inst. Elect. Engin., Trans. 20. pp. 495–505, April, 1903.)—The author describes his system by which the dynamo is driven from the axle of the carriage, and the voltage kept constant by means of a variable resistance inserted in series with the field winding, and, if necessary, another resistance in series with the lamps during the time the battery is being charged. The details of the regulating mechanism are fully described. W. H. S.

1057. *Felt Train-lighting System.* (Elect. World and Engineer, 41. pp. 494–495, March 21, 1903.)—The dynamo is driven at constant speed from the axle, on which latter a disc is mounted which drives friction pulleys bearing against its surface. The pulleys are capable of motion to and from the centre of the disc, and their position is controlled by an ordinary ball governor. The dynamo is mounted on the same spindle as the pulleys.
W. H. S.

REFERENCES.

1058. *Mechanics of Overhead Lines.* **Brunhes.** (Assoc. Ing. Él. Liége, Bull. 2. pp. 586–603; Discussion, pp. 603–604, Nov. and Dec., 1902.)—The author deals with the mathematical derivation of formulæ for determining the form and tension of overhead lines, both when unloaded and when carrying moving loads, as in telpherage, or subject to forces equivalent to moving loads, such as the pressure of a trolley. G. W. DE T.

1059. *Calculation of Distributing Networks.* **H. Gallusser.** (Elektrotechn. Zeitschr. 24. pp. 310–315, April 23, 1903.)—This paper describes an extremely elegant method of determining the distribution of currents in a complicated network of conductors fed at a number of points, the method not involving the solution of a system of simultaneous linear equations. A. H.

1060. *Electricity Supply Works Costs.* (Electrician, 50. pp. 431–438, Jan. 2, 1903.) —The more interesting data given in *The Electrician* analyses of electricity supply works accounts for 1900–1901 are here summarised in tables and curves.
G. W. DE T.

Digitized by Google

TELEGRAPHY AND TELEPHONY.

1061. *Recent Experiments in Wireless Telegraphy.* **A. Turpain.** (Écl. Électr. 32. pp. 13–25, July 5; 281–287, Aug. 23; and pp. 337–351, Sept. 6, 1902.)—This article gives a general survey of recent work done in the department of wireless telegraphy, dealing first with Marconi's experiments in communication between France and Corsica, and Sardinia and Italy. [See also Abstract No. 2503 (1901).] He then reviews the work of Tissot on the period of the waves used, on the use of aerial wires, and his researches on coherers [see Abstracts Nos. 1518 (1901) and 491 (1902)], and finally describes the Guarini repeater and experiments made therewith between Brussels, Malines, and Antwerp. [See Abstract No. 2504 (1901).]

L. H. W.

1062. *Portable Wireless Telegraph Stations for Military Purposes.* **A. Wilke.** (Elektrotechn. Zeitschr. 24. pp. 40–44, Jan. 15, 1903.)—The author describes the wireless telegraph equipment of a movable station designed by Siemens and Halske for use in the German Army. This consists of a couple of two-wheel carts exactly resembling ordinary ammunition wagons. The limber contains the receiving apparatus enclosed in the body under the seats, and underneath are stored the gas cylinders for inflating the balloons carried for elevating the aerial wire. The tumbril is equipped with the coil and transmitter apparatus forward, and a 5-h.p. water-cooled horizontal benzine motor, to run at 800 r.p.m., and driving a 2·5-kw. dynamo giving 120 volts, at the rear. The instrumental equipment is on the Braun closed circuit oscillating system. [See Abstracts Nos. 1464 (1901) and 1266 (1902).] The staff consists (besides drivers) of one officer, one non-commissioned officer, and five privates. The average distance communication is carried on at 40 to 50 km., but occasionally it is as much as 60 to 80 km.

L. H. W.

1063. *Selective Wireless Telegraphy.* **A. Bull.** (Electrician, 50. pp. 418–422, Jan. 2, 1903.)—A description, with illustrations, of the apparatus for transmitting and receiving wireless messages by means of the author's synchronous impulse system [see Abstract No. 740 (1901)]. Reproductions are given of two tapes showing the difference in the same signals as recorded by the author's receiver and by an ordinary receiver circuit, and others showing three tapes simultaneously unwound by three Morse inkers when words were sent by the transmitter in each of three series, corresponding to the three machines, successively. These tapes show that when one machine was working, neither of the other two recorded any signal. The distance in these experiments was about 100 yards. L. H. W.

1064. *Lodge-Muirhead Wireless Telegraph System.* **H. C. Marillier.** (Electrician, 50. pp. 930–934, March 27, 1903.)—This article describes in a popular manner the now perfected apparatus used in the above system. The feature is the mercury coherer, described at some length. This consists of a steel disc with a sharp edge dipping into a small pool of mercury, on the top of which latter is a film of mineral oil. The oscillations, on arrival, break down the film of oil, establishing contact between the disc and the mercury.

Digitized by Google

Owing to the disc being continuously rotated, the contact is at once broken again, and the film re-established, being thus automatically kept in the wave-sensitive condition. The disc is driven by means of ebonite gear wheels from the siphon-recorder clockwork, the moving coil of the recorder being included in the coherer circuit without the intervention of a relay. The p.d. at the terminals of the coherer can be varied by a potentiometer arrangement between 0·03 volt and 0·5 volt, as required. The system has been tried over a range of 8½ miles in Kent, and over the official range of 62 miles between Portsmouth and Portland. Diagrams of the receiver and transmitter circuits are given. [See also Abstract No. 1108 (1899).] L. H. W.

1065. *Antennæ in Wireless Telegraphy.* **Q. Majorana.** (Elettricista, Rome, 12. pp. 81–82, April, 1903.)—The author supports Lecher's view as to the part played by the earth. For transmission to great distances, the transmitting apparatus should radiate energy straight upwards, and the receiving apparatus would be acted upon through the earth. A. D.

1066. *Wireless Telegraphy.* **E. A. N. Pochin.** (Electrician, 51. pp. 877–878, June 19, 1903. A paper read before the Institution of Civil Engineers at the Engineering Conference, 1903.)—The author refers to recent facts which have been established [(1) earth curvature no fatal obstacle, but hills may exert serious influence; (2) variable transparency of the ether and effect of sunlight], and thinks it probable that certain wave-lengths offer special advantages. He then refers to the two usual methods of securing isolation, viz., syntonic methods, and optical methods. As regards the former, he thinks that practically no great degree of privacy is possible by this means, and points out that sharp tuning at low frequency means slow signalling. With the latter (as in Blochmann's system), the difficulty is to radiate a large amount of energy from a small area. The author deplores the lack of a metrical detector, by which results would be obtained with much less labour. As regards the production of wave-trains, the use of alternators for this purpose is referred to. A discussion followed. L. H. W.

REFERENCES.

1067. *Hertzian Wave Telegraphy.* **J. A. Fleming.** (Soc. Arts, Journ. 51. pp. 709–727, July 24; 731–748, July 31; 749–767, Aug. 7; and pp. 770–784, Aug. 14, 1903.)—A series of four Cantor lectures on the above subject dealing in order with (1) General principles. The theory of the radiator or aerial. (2) Transmitting arrangements and transmitters. (3) Receiving arrangements and receivers. (4) Hertzian wave telegraphy. Though not disclosing many new features of interest, these papers furnish a valuable general summary of the work done in the different departments of wireless telegraphy, with references to the original papers, supplementary to the lectures by the same author on electric oscillations and waves. [See Abstract No. 1135 (1903).] L. H. W.

1068. *Telegraphic Manipulator for Continuous Currents.* **Marchesini.** (Elettricista, Rome, 12. pp. 44–45, Feb., 1903.)—A description of a simple manipulator by O. and A. Gallego, designed to overcome the disadvantages of the Forcieri instrument. A. D.

1069. *Italian Wireless Telegraph Stations.* **A. Banti.** (Elettricista, Rome, 11. pp. 113–119, May, 1902.)—The article describes the equipment of stations at Palmaria, Gorgona, and Leghorn. G. W. DE T.

Digitized by Google

NAME INDEX.

SECTION B.—ELECTRICAL ENGINEERING.

[*Names not followed by Titles are not Authors, but only names mentioned in Abstracts. The numbers refer to Abstracts, those in Italics referring to References. An asterisk indicates remarks in a discussion.*]

Abbott, A. V., consumption of electric elevators, 175*; telephones, 248
Abney, W. de W., photometry, 718*
Abraham, A., power, 177
Abraham, A. J., earthing, 94
Acker, 998
Adams, A. D., equipment, 732; Hamilton plant, 104; pole lines, 551; Portland supply station, 559; transformers, 902; transmission, 300; transmission, 901; transmission costs, 515; water power, 590, 723
Adams, C. A., & A. E. Kennelly, resistance of bearings, 686
Ados, 254
Aldrich, W. S., power in navy yards, 728
Aliamet, M., energy meters, 535; meter, 632
Allen, W. H., Vancouver plant, 913
Alteneck, F. v. Hefner-, standard lamps, 999A
Anderson, Harris-, 614
Andersson, K., 852; steam turbines, 460
Andrews, *592*, 1007
Andrews, L., generators, 70*
Andrews, T., & C. R. Andrews, platinum and stress, 192A
Andrews, W., steam piping, 451; steam piping, 613
Anizan, J, telegraph, 442
Appleyard, R., tramways, 709*
Arcioni, graduation of apparatus, *700A*
Arendt, 800
Arldt, C., theatre installation, 1043
Armagnat, magnetic measurements, 934A
Armengaud, J., Jr., 33
Arndt, 608
Arndt, K., 380
Arno, R., meters, 683; power measurement, 577
Arnold, generators, 287*; lubrication, 253*
Arnold, B. J., braking and brake tests, 713*; rails, 798; railway, 654*; speed control, 628*
Arnold, E., *294*, 634; distribution, 366
Arnold, J. O., & A. M'William, steel, 136A
Aron, 535, *632*
Arons, 381
Artemieff, N., protective clothing, 879
Arter, A. M., indicator diagrams, 847
Artom, A., polarised electric waves, 1232A
Arthur, 332
Ashcroft, 347
Ashworth, J. R., dynamos, 361; drawn steel, 1268A
Aspinall, J. A. F., train resistance, 114
Atkins, 399
Atkinson, R. E., pipe flanges, 465
Austin, L., conduction, 811A
Aultman, 836
Ayrton, Mrs. H., arcs, 1046A
Ayrton, W. E., tramways, 709*

Bach, C., belts, 852; boiler explosion, 744; boiler explosions, 984; iron, 618A
Baillie, G. H., transmission lines, 90
Bainville, A., projector, 239; surface contact, 711; wattmeter, 999
Bairstow, L., & E. C. Horsley, explosions, 1022A
Baker, C. H., L. Denis, P. N. Nunn, H. J. Gille, & P. M. Lincoln, line protection, 439

Digitized by Google

Balcke, 331
Banovits, 222
Banti, A., 887; converters, 492: Duddell circuits, 1047A; wireless telegraphy, 1069
Barbillion, traction motors, 1025
Barnard, A. S., high-tension continuous-current, 89
Barnes, J. F., gauge, 775
Barrett, W. F., water power, 86*
Barrett, W. F., W. Brown & R. A. Hadfield, iron alloys, 335A
Barrus, G. H., steam-pipe coverings, 7
Barry, J. W., traction, 710*
Battelli, F., shocks, 1258A
Bauart, Lentz, 851
Bauch, 634; generators, 189*
Bauch, R., armature reaction, 284
Baudot, 410, *599*
Baumann, J., telephones, 522
Beadle, A. A., electro-metallurgy, 347
Beardmore, C. E., 526
Beare, T. Hudson, non-conducting compositions, 389
Beattie, R., alternators, 74; quantometer, 736A
Beaulard, F., oscillatory discharges, 471A
Becker, H., electric furnace, 997; Hall process, 996
Bedell, 697
Bedell, C. H., magnet and arc, 327A
Bedell, F., 366
Bedson, J. P., liquid fuel, 394*
Beecher, A. M., wireless telegraphy, 735
Beeton, 56
Behn-Eschenburg, 634, 889
Behn-Eschenburg, H., four-speed motor, 547; motors, 362; 30,000-volt transmission, 596
Behrend, engines, 462
Behrend, B. A., surges, 88*
Bell, H., train resistance, 114*
Bellangé, G., 377
Bellet, D., voiturette, 28
Belloc, G., steel, 1481A
Belugon, V., elevators, 52
Bender, C., & F. Winawer, cranes, 485
Benischke, switchboards, 875
Benischke, G., 363, 692, 876; alternators, 888
Benjamin, *228*
Benton, J. R., elasticity, 1135A
Benz, 967
Bergmann, D., motors, 490
Bertolus, C., Keller furnace, 624
Betts, 348
Bever, 144
Bianchi, A., circuit-breaker, 636
Bickford, J. S. V., boilers, 449
Bienaimé, *640*
Bigge, Selby-, D., power, 178
Bignami, E., carbide factory, 397
Blackwell, F. O., insulators, 878; surges, 88*; tool motors, 544
Blaess, V., efflux of steam, 812A
Blanc, F., 694
Blanck, W., high-pressure transmission, 719
Bleekrode, L., wireless telegraphy, 322
Bliss, E. F., signalling, 138
Bliss, W. L., train lighting, 939
Blochmann, G. F. R., 243
Blondel, 634, 691, 889, 936
Blondel, A., & J. Rey, photometry, 225; oscillographs, 840A
Boardway, E. E., hydro-electric plant, 910
Bodensteiner, F., motors, 363
Body, 347
Böhm, *949*
Böhmländer, H., alternators, 194
Böhm-Raffay, B., dynamo, 69
Boot, H., distribution, 91*
Booth, W. H., boiler, 250; combustion, 261; engines, 827; fuel, 609, 610
Borchers, 347; zinc ores, 469
Borgmann, J. J., electric waves, 1231A
Böttcher, A., shipbuilding plant, 924
Boucherot, alternators, 73*, 75; railway, 917
Boucherot, P., 446
Bourguignon, carbon brushes, 633
Bowen, C. A., feed waters, 262
Bowman, F. M., coal storage, 8
Boyd, W., liquid fuel, 394*
Boy de la Tour, 784; alternators, 780; Heyland's motor, 82; induction motor, 782
Boynton, H. C., & A. Sauveur, structure of steel, 1012
Boys, C. V., tramways, 709*
Bradley, C. S., 167
Bragstad, 366
Bragstad, O. S., & J. L. la Cour, motors, 692
Braid, G. G., tramway poles, 809
Bramwell, F., traction, 710*; train resistance, 114*
Bräuer, K., motor boats, 843
Braun, F., 242; magnetisation, 1252A
Braun, K., generators, 189*
Breslauer, M., motor air-gaps, 690; motor coupling, 691; transformers, 642
Brewer, 347
Brewer, R. W. A., gas producers, 961
Brion, G., iron testing, 1019
Brooke, 617
Brooks, F. W., with W. O. Wood & A. C. Marshall, railway, 209

Digitized by Google

Brouhot, 753*
Brown, 117, *846*
Brown, C. E. L., traction, 710*
Brown, E., miners' lamps, 353
Brown, Hall-, E., marine engines, 676
Brown, W., W. F. Barrett, & R. A. Hadfield, iron alloys, 335A
Browne, 865
Browne, D. H., pumps, 1015
Bruger, T., motor meters, 266; network resistance, 423
Brunhes, overhead lines, 1058
Brunhes, L., electric capstans, 629; motors, 788
Brunswick, carbon brushes, 633*
Brunswick, E. J., refinery plant, 925; wave-windings, 294
Bach, H. W., education, 185
Bugatti, Dietrich-, 968
Bull, A., wireless telegraphy, 1063
Burdick, E. J., power curves, 232
Burger, 960
Burgess, C. F., & C. Hambuechen, electrolytic rectifiers, 1014; galvanising, 265; metal deposits, 763
de Burlet, C., light railways, 118
Burnand, 291
Burnett, D., illumination, 595
Burstyn, W., & H. Paweck, voltametric balance, 1123A
Bussmann, O., Nernst lamp, 1054
Butler, 828
Büttner, 222, 938

Caël, J., carburetter, 346
Callendar, 667
Calvert, 14
Campbell, E. D., & M. B. Kennedy, new iron carbide, 498A
Campbell, G. A., telephone lines, 953
Campbell Swinton, A. A., electric railways, 115*
Carpenter, J., galvanometer, 1239A
Carter, O. M., railway, 501
Carus-Wilson, C. A., electric railways, 115*; tram resistance, 114*
Cawley, G., liquid fuel, 394*
Chaboche, 964
Challenger, C., signals, 571
Chamen, W. A., motor control, 892*
Chanute, O., 844
Charpy, G., cementation of iron, 1010
Charpy, G., & L. Grenet, steel, 1197A
Charron, 837
Chatel-Jeannin, 24
Chatelier, A. le, steel, 1482A
Chatelier, H. le, & M. Ziegler, iron sulphide, 1093A
Chattock, R. A., central stations, 1028; distribution, 91*
Chavoutier, C., ballooning, 33
Chénard, 620, 971
Chérié, M., automobile, 975; Darracq 12-h.p. car, 343
Chesney, C. C., insulators, 1031
Chick, Miss H., W. Ramsay, & F. Collingridge, gutta-percha, 674A
Chree, C., train resistance, 114*
Christie, W. W., stoking, 258
Chubb, I. W., pumping, 278
Civita, D., traction, 799
Clark, C. C., 766
Clark, C. M., telpherage, 124
Clark, E. B., braking and brake tests, 713*
Clarkson, T., lubrication, 841
Claude, G., 709
Clément, 152, *855*
Clowes, F., tube's atmosphere, 1008
Cobb, J. W., non-conducting coverings, 819*
Coburn, F. W., H. Fay, & A. W. Higgins, axle steel, 929
Cochrane, C. A., 962; gas engines, 456
Coho, H. B., 628; storage battery, 480
Collingridge, F., W. Ramsay, & Miss H. Chick, gutta-percha, 674A
Collins, A. F., wireless telegraphy, 242; wireless telegraphy, 600
Collischonn, F., double-current generators, 890
Columbia, 28
Conrad, R., *850*
Considère, concrete, 280A
le Conte, J. N., piston, 256
Conway, G. R. G., Aberdeen subway, 589
Coolidge, W. D., & F. A. Laws, voltmeter calibration, 256A
Cooper-Hewitt, 638
Cooper, W. R., traction systems, 116
Cooper, W. R., & J. Swinburne, electric railways, 115
Corbett, J., sewage, 467
Cornut, 252
Cottrell, S. B., traction, 710*
Couper, S., boilers, 608*
la Cour, 366
la Cour, J. L., & O. S. Bragstad, motors, 692
Cowper-Coles, 347
Cravath, J. R., braking and brake tests, 713*
Crewe, 378
Cristoforis, G., tramway batteries, 594
Crompton, 531
Crompton, R. E. B., traction, 710*; tramways, 709*
Crouan, 965
Crova, 718
Crowell, R., & C. W. Hutton, transmission, 365
Cruse, H., superheaters, 38
Cruvellier, 119

Digitized by Google

Curtis, R. E., joint, 257
Curtis, R. E., & I. E. Moultrop, Edison Station, 95
Cutler, speed control, 628*

Dal, A., peat fuel, 823
Dalemont, J., armatures, 639
Dales, J. H., governors, 329
Danielson, E., 691
Dankwardt, telephone switchboard, 740; telephony, 245
Darcelle, 833
Darracq, 343
Datterer, 818
Datterer, L., Berlin Station, 560
Davey, H., tramways, 709*
David, L. E. F., 446
Davies, F. W., armature discs, 293; armatures, 191
Davies, S. H., non-conducting coverings, 819
Davis, C. H., 120
Dawson, P., traction, 710*; tramways, 709*
Day, A. A., engines, 159
Dean and Main, steam turbine, 605
Decauville, 835
Delagneaux, 839
Delahaye, 752
Denham, J., alternator, 417
Denis, 755
Denis, L., C. H. Baker, P. N. Nunn, H. J. Gille, & P. M. Lincoln, line protection, 439
Deprez, M., 89
Déri, 287
Desdouils, 114
Deslandres, H., 33
Desolle, 164
Dettmar, G., lubrication, 253; standardisation, 360
Diatto, 116, 117
Dick, E., commutation, 84; rheostats, 298
Diesel, *862*
Dittenberger, W., metal expansion, 639A
de Dietrich, 22
Dietrich-Bugatti, 968
Dieudonné, E., carrier-tricycle, 800
Digby, W. P., Taeggi's Post, 220
Dinger, H. C., boilers, 821
Dion, A. A., Ottawa Lighting, 96
Dittenberger, W., metal expansion, 639A
Dobrowolski, 421
Dodd, S. T., variable speed control, 627*
Dolezalek, F. & A. Ebeling, telephone lines, 665
Dolter, *234*
Donkin, 607
Donkin, B., blast-furnace gases, 849
Dorsemagen, 469
Döry, I., B-H curve, 1004; Steinmetz's formula, 107A
Dow, electric railways, 115*
Drago, E., coherers, 476A
Dreihardt, C., launches, 670
Drouin, F., bearings, 988; surface contact, 119
Druart, 218
Drude, P., oscillatory discharge, 839A
Dubs, H., Marseilles tramways, 306
Dudley, P. H., 712
Dufour, C., factory plant, 101
Dulong, 252
Dumas, A., Vouvry plant, 371
Dumont, Santos-, 33, 980
Duncan, L., railroading, 565
Dunlap, O. E., siloxicon, 871
Dunlop, 959
Dunlop, J., gas engines, 259
Dunn, G. S., variable speed control, 627*
Durand, C. L., Paris railway, 1047
Duryee, E., power plant, 703
Dussaugey, line protection, 198
Duvinage, 13

Earl, 619
Eastwood, 168
Ebeling, A., & F. Dolezalek, telephone lines, 665
Edelmann, Roessler-, 264
Edison, 43, *240*, 990
Edwards, A. E. A., traction, 39
Ehnert, E. W., five-phase system, 698
Ehrdardt, 181
Eichberg, 1027
Eichberg, F., *899*; asynchronous generators, 288*; generators, 287; transformer, 494
Eichhorn, M. J., power cost, 229
Eisig, M., power stations, 580
Elisha Gray, 747
Ellicott, E. B., fire alarms, 521
Emde, F., self-inductance, 899
Emmet, L. R., 421
Engelhardt, 767
Erhard, T., magnetometric errors, 741A
Erlacher, G. J., resistances, *297*; rheostats, 67
Erlwein, G., water purification, 765
Ernst, W. E., boiler scale, 743
Eschenburg, Behn, 634, 889
Eschenburg Behn H., four-speed motor, 547; motors, 362; 30,000 volt transmission, 596
Espitallier, G., aeronautics, 845
Esson, W. B., earthing, 93*; electrical design, 881; generators, 70*
Evans, E. A., railways, 120
Ewing, superheated steam, 667
Ewing, J. A., engine test, 604

Digitized by Google

Fairburn, W. A., boilers, 396
Faraday Proctor, H., distribution, 91*; earthing, 93
Farmer, T., power stations, 211
Farnsworth, A. J., train lighting, 937
Farwell, E. S., boilers, 820
Fawcett, W., track welding, 1050
Fawcus, G. H., brakes, 223
Fay, H., A. W. Higgins, & F. W. Coburn, axle steel, 929
Fay, T. J., accumulator locomotives, 436
Fedden, G. E., steam turbines, 158
Feldmann, 944
Fell, A. L. C., station working, 85
Felt, 1057
Fényi, J., coherers, 1062A
Ferber, 844
Fergusson, H. A., draw-bar pull, 660
Ferranti, 271
de Ferranti, S. Z., high-tension continuous-current, 89*
Ferrini, R., high temperatures, 319A
Fessenden, 531
Field, M. B., 784; dynamo design, 884*; electrical novelties, 277; tramway motors, 126
Finckl, F., pressure rise, 779
Finzi, L., dynamos, 777
Fischer, 154, 408
Fischer, F., Bessemer process, 152A; p.d. measurement, 1236A
Fischer-Hinnen, 283, 287
Fisher, H. K. C., 952
Fisher, H. W., surges, 88*
Fitzgerald, F. A. J., carbon electrodes, 1018
Fitzgerald, F. J., graphite, 481
Flather, J. J., power transmission, 700
Fleming, J. A., Hertzian telegraphy, 1067; photometry, 718
Fletcher, engines, 157
Foerster, W., 865
Fontaine, H., copper plating, 164
de Forest, 386
Forest, F., launches, 345
Förster, E., indicator springs, 826
Forster, F., stress repetition, 866A
Foster, E., superheated steam, 527
Foster, F., steam, 860
Foster, W. E., & J. C. Mock, signals, 514
Fournier, J., boiler explosions, 6
Fournier, L., aeroplanes, 844; automobile, 837; automobile, 966; Brouhot cars; 753; Clement automobile, 152; extensible pulley, 839; motor bicycle, 974; repair trolley, 584; voiturette, 341, 855
Fowler, G. W., speed control, 507; boilers, 463, 606
Fox, D., traction, 710*
Frahm, H., engine stress, 2
Frank, K. G., relay, 1262A
Franke, angular velocity, 327*
Franke, A., telephone lines, 598
Fränkel, E., railroad electrification, 504
Frankenfield, B., power-factor, 92
Franklin, 27
Franklin, W. S., model, 1035
Frasch, 865
Frémont, C., rail testing, 928; elastic limit, 190A
Frerichs, C., winding engines, 182
Freund, H. P., F. Townsend, & W. I. Reich, alternators, 542
Freund, J., commutation, 413
Fricker, 1000
Friedman, 25
Friese, 1023
Fritts, C. E., cable, 241
Fry, D. H., pumping, 180
Fulton, W. M., 775
Fumero, railway, 430

Gallego, A., *1068*
Gallego, O., *1068*
Gallusser, H., networks, 1059
Galton, 712
Ganelin, 347
Ganz, 933
Garrard, C. C., fuses, 877
Garreau, 974
Garuti, 767
Gary, M., conduits, 524
Gassner, R., Ludwigshafen Works, 199
Gauduin, 164
Gaylord, T. P., braking, and brake tests, 713*
Geer, W. C., mercury lamp, 381
Geipel, W., electric railways, 115*; traction, 710*
Geldard, J., stoking, 759
Genuardi, P., type-printer, 955
George, H., naval uses, 270
Georges, Richard, 966
Gérard, *944*
Gerard, L., European stations, 906; naval construction, 66; superheating, 818*; traction, 509
Germain, 622
Gibbs, G., locomotives, 276
Gibson, G. H., railways, 517
Gill, A. H., & H. R. Healey, naphthas, 320A
Gille, H. J., C. H. Baker, L. Denis, P. N. Nunn, & P. M. Lincoln, line protection, 439
Gillon, G., osmium lamps, 575; traction, 733
Girardot, 837
Girault, carbon brushes, 633*
Girault, P., motors, 688

Digitized by Google

Glazebrook, R. T., photometry, 718*
Glinski, H. v., droop in wires, 1029
Gmelin, 252
Godfrey, C., 953
Goffin, J., drainage, 181
Gola, G., lightning arresters, 172
Golden, M. J., ball bearings, 979
Goldschmidt, H., 264; steel, 870; aluminothermy, 1299A
Goldschmidt, R., hunting, 541
Gonzenbach, E., speed control, 628*
Goodman, load-strain recorder, 695A
Goodrich, W. F., destructors, 255
Goodrum, C. L., switchboards, 525
Goransson, K. F., H. M. Howe, steel, 1090A
Görges, 73, 493, 548; asynchronous generators, 288*; generators, 189*
Görges, H., 888, 1023; induction motor, 895; paralleling alternators, 1024
Görner, J., power measurement, 1001
Gotshall, W. O., braking, 712*
Goufal, coal, 252
Grallert, telegraph station, 444
Grange, 508
Granger, A., aluminium, 1024A
Grant, S., rails, 661
Grassi, G., transformers, 785
Gratzmuller, carbon brushes, 633*
Gratzmuller, L., alternator, 419
Gray, 572
Gray, Elisha, 747
Greth, 980
Grotrian, O., coreless dynamo, 886
Grübler, M., brittle bodies, 696A
Guarini, E., coherer, 246
Guédon, Pierre-, L., motor coach, 976
Guérin, H., mazout, 32
Guilbert, C. F., alternators, 634; harmonics, 104A
Guillaume, C. E., nickel steel, 1133A, 1134A, 1200A, 1386A
Guillet, L., alloys, 584A; constitution of steel, 1020; nickel steel, 1013, 1092A
Güldner, H., motors, 850
Gulstad, K., relay, 143
Günther, E., nickel separator, 866

Haas, lubrication, 253*
Hadfield, R. A., W. Brown & W. F. Barrett, iron alloys, 335A
Haeffner, 351
Hagen, G., water-electrolyser, 764
Hagen, R., 21
Hall, 264, 572, *630*, 772, 996
Hall-Brown, E., marine engines, 676
Hall, J. L., alloys and steam, 1265A
Hall, L. M., mining equipment, 215
Halligan, J., boiler tests, 822
Halpin, D., train resistance, 114*
Halsey, F. A., metric system, 987A
Halske, 347, 477, *944*
Hambuechen, C., & C. F. Burgess, electrolytic rectifiers, 1014; galvanising, 265; metal deposits, 763
Hammer, W. J., calcium lamp, 240
Hanchett, G. T., collectors, 233; third-rail, 801
Hansen, 155
Harcourt, A. V., photometry, 718*
Härdén, J., mica, 1007
Harmet, 398
Harris-Anderson, 614
Harris, M., water power, 86*
Hart, 973
Hartman, W., four-cylinder chain, 854
Haskins, C. D., military devices, 282
Hautier, 832
Hazen, *880*
Healey, H. R., & A. H. Gill, naphthas, 320A
Heaviside, 665
Hecker, A., steam *v.* water power, 701
Heerwagen, F., 50, 458
v. Hefner-Alteneck, F., standard lamps, 999A
Heilmann, J. J., accumulator, 760
Heinicke, *537*
Heinke, C., transformer, 420
Hellmund, R., binding screws, 403; slip-rings, 414
Henning, F., & W. Holborn, platinum, 76A
Henning, G. C., extensometer, 289A
Henriod, 19
Hentze, W., hydraulic gauge, 169
Hering, C., battery curves, 530
Hering, R., 149
Héroult, *630*
Herschel, C., turbine, 471
Heubach, E., drills, 61
Hewetson, 342
Hewitt, 434
Hewitt, Cooper-, 638
Heyland, 289, 634, *642*, 691
Heyland, A., *82*, 493, 548, 782, 783; alternators, 73, 781; asynchronous generator, 288*; compounded machines, 898
Heyn, E., copper and steel, 1087A; sickening of iron, 769A; steel, 1089A
Hiecke, R., regulation plant, 905
Higgins, A. W., H. Fay, & F. W. Coburn, axle steel, 929
Highfield, 56; earthing, 93*
Highfield, J. S., distribution, 91*
Hill, 608
Hinnen, Fischer-, 283, 287
Hird, W. B., dynamo design, 884*
Hirn, 818
Hobart, 192, 283

Digitized by Google

Hobart, H. M., dynamos, 486 ; electrical machinery, 786
Hobart, J. F., engine stops, 36
Hockin, 349
Hoepfner, 347, 865
Hoff, S. S., railways, 505
Hoffmann, E., mining plant, 310
Hofman, H. O., aluminium, 264
Hohenstein, 450
Hohl, C., Lagos Station, 375
Holborn, L., & F. Henning, platinum, 76A
Holden, J., traction, 710*
Holden, S. H., intermittent currents, 716
Holitscher, P., conductors, 272
Hollard, A., lead peroxide, 1119A
Holroyd-Smith, M., electric railways, 115*
Hood, Jacomb-, J. W., traction, 316
Hooghwinkel, G., earthing, 94
Hopkinson, B., dynamos, 532
Hopkinson, B., E. Talbot, & C. Hopkinson, tramways, 709
Hopkinson, C., pumping plant, 406
Hopkinson, C., E. Talbot, & B. Hopkinson, tramways, 709
Hoppe, 181
Horsley, E. C., & L. Bairstow, explosions, 1022A
Hoskins, W., electric furnaces, 400
Hospitalier, *981* ; carbon brushes, 633*
Houghton, S. A., structure of steel, 1021
Housman, *640*
Houston, W. C., Pelton wheel, 372
Howard-Smith, W., rail sections, 926
Howe, G. W., switch testing, 1005
Howe, H. M., & J. E. Johnson, cast iron, 1091A
Howe, H. M., & K. F. Goransson, steel, 1090A
Huber, E., traction, 710*
Huber, Tony, 834
Hudleston, F., traction, 710*
Hudson Beare, T., non-conducting compositions, 389
Huff, W. B., arc spectrum, 91A
Hughes, *955*
Huinen, 802
Hult, 324
Humber, 29
Humfrey, J. C. W., lead, 1098A
Humphrey, H. A., gas engines, 848
Hundhausen, R., armature plates, 641 ; fuses, 1016
Hunter, W. D., Newcastle station, 424
Hurd, 407
Hutchinson, G. A., mechanical stokers, 824
Hutton, C. W., & R. Crowell, transmission, 365
Hutton, R. S., & J. E. Petavel, electric furnaces, 768

Ilgner, 477, 1034
Iliovici & P. Janet, large currents, 1245A
Inkersley, A., airships, 980
Isaachsen, 328
Ivel, *26*

Jackson, H. B., wireless telegraphy, 811
Jacob, 998
Jacobs, C. B., furnace, 188
Jacomb-Hood, J. W., traction, 316
Jacquin, C., train lighting, 574, 938
Jamieson, A., tramway motors, 126*
Janet, P., & Iliovici, large currents, 1245A
Jandin, 181
Janssen, L., light railways, 118*
Jeannin, Chatel-, 24
Jebsen, 42
Jenkin, B. M., & W. M. Mordey, traction, 710
Jervis-Smith, F. J., spark-gap, 251A
Jobst, P., brakes, 171
Joel, H. F., Edison battery, 43
Johnson, F. A., 545
Johnson, F. L., earth returns, 585
Johnson, J. E., Jr., & H. M. Howe, cast iron, 1091A
Johnson, K. R., gramme ring, 1244A
Johnson, W. McA., electrodeposition, 868
Johnston, A., faults, 725
Johonnott, E. S., phasemeter, 738A
Jones, *462*
Jones, R. M., Pike's Peak, 99
Jona, E., sparking in air and oils, 249A
Jordan, C., Matzleinsdorf Station, 317
Josse, E., private installation, 1045
Jottrand, F., electrolysis, 767

Kahlenberg, L., electroplating, 762
Kammerer, 267 ; conveyors, 405
Kamps, H., transformer stampings, 693
Kapp, 267, 634, 1023, 1034
Kapp, G., traction, 710*
Kareis, electric clocks, 534
Kehr, telephones, 814
Keiley, J. D., 712, 713 ; brake tests, 655
Keilholtz, P. O., 628 ; hoist, 479
Keith, 347
Keith, N. S., electrolytic copper, 40
Keller, 624
Kelly, Stanley-, 418
Kelsey, W. R., gyrostatic action, 37 ; motor, 491
Kelvin, traction, 710*
Kennedy, 531

Digitized by Google

Kennedy, A. B. W., 207; traction, 710*; tramways, 709*
Kennedy, M. B., & E. D. Campbell, new iron carbide, 498A
Kennelly, A. E., & C. A. Adams, resistance of bearings, 686
Kent, W., steam-pipe coverings, 7*
Ker, W. A., dynamo design, 884*
Kerbaker, E., motor heating, 635
Kershaw, J. B. C., chlorates, 482
Kersten, M., drainage, 181*
Kesselring, F., alternators, 415
Kestner, Scheurer-, 252
Ketterer, M. A., coherer, 1063A
Kingsbury, J. E., telephone, 249
Kinzbrunner, C., rheostats, 891
Kjellin, 997
Klein, *256*
Klingenberg, 20
Klönne, F., angular velocity, 327
Knowlton, E., alternators, 72
Knudson, A. A., *586*
Koehler, G., brakes, 130*
Koepe, 477
Kohlfürst, L., signalling, 657; signals, 137
Kohlrausch, 863
Kollert, ammeters, 478A
König, A., transformers, 694
König, E., rectifiers, 1445A
König, G., networks, 721
Koppitz, E. J., Swan Falls, 429
Korda, railway, 917*
Korda, D., railway, 942
Korrodi, E., dynamos, 538
Körting, 672
Köttgen, *944*
Köttgen, C., winding machinery, 47; winding plant, 267
Krause, R., rheostats, 80
Krebs, A., carburettor, 856
Krell, O., Jr., lighthouse plant, 1055
Krizik, 802
Krohne, K., wire spans, 318
Kübler, generators, 189*
Kübler, W., windings, 197
Kull, 382, *949*
Kummer, W., drainage plant, 275; superheating, 818*
Kylberg, F., works electrification, 176

Lacombe, C. F., 909
Lacy, E. M., tramways, 709*
Lambe, A. B., car equipment, 133
Lambot, A., electric clocks, 408
Lamme, B. G., railway, 654
Langdon, W. E., electric railways, 115*
Lange, E. F., steel, 1267A
Langner, H., cranes, 484
Larmoyer, motors, 783
Larroque, F., Hertz waves, 472A
Larsen, 347
Larsen, A., earth returns, 435, 511
Lasche, *988*
Lasche, O., bearing friction, 816
Latchinov, 767
Latour, 493
Latour, M., alternators, 73*; single-phase motor, 893
Lauriol, Paris supply, 659; supply statistics, 643
Lauriol, P., charging for energy, 557
Laws, F. A., & W. D. Coolidge, voltmeter calibration, 256A
Lea, H., motor control, 892*
Leblanc, 495, 1024
Lecher, 1065
Leduc, cable, 813
Legros, 842
Lehotzky, A., 876
von Leiber, brakes, 130*
Leimer, E., accumulators, 864, 989
Lemaitre, G. E., 616
Lentz, Bauart, 851
Leonard, 267, 479
Leonard, Ward, 710
Leonard, H. Ward, multiple unit, 567; variable speed control, 627*
Lépine, generating station, 302
Le Roy, 218
Letheule, P., train-lighting, 489
Lewicki, L., boiler trials, 742
Lewicki, E., steam turbine, 817
Lewis, E. A., Muntz metal, *1039A*
Lincoln, P. M., telephone lines, 954
Lincoln, P. M., H. J. Gille, P. N. Nunn, L. Denis, & C. H. Baker, line protection, 439
Lindström, A., motor calculations, 81
List, J., 4
Lister, 12
Little, W. G., 147
Locke, *160*
Lockwood, T. D., telephone switchboard, 741
Lodge, 1064
Loomis, H. B., magnets, 1248A
Loppé, 489
Loppé, F., alternators, 889; dynamos, 411; harmonics, 105A; resistances, 58; water power, 724
Lorain, 1049
Louis, 664
Lovejoy, B. R., 167
Low, G. P., fire risks, 77
Lowne, 1009
Löwy, J., machinery novelties, 696
Lozier, R. T. E., 628; shop driving, 472
Lucke, C. E., liquid fuel, 9
Ludwig, A., melting carbon, *372A*
Lukes, G. H., high-tension work, 230
Luraschi, A., networks, 720
Luzzati, telephones, 715
Lyte, 347

Digitized by Google

M'Allister, A. S., 555; Bedell system, 697; converters, 550; generator excitation, 897; motors, 637; power factor, 554
McCowen, V. A. H., distribution, 91*; earthing, 93*
McElroy, J. F., train lighting, 1056
McFarland, naval uses, 357
McKnight, E. H., hot-water heating, 658
M'Lean, M., motor control, 892*
McLellan, R. A., Korean plant, 367
McMahon, P. V., electric railways, 115*; traction, 710*; train resistance, 114*; tube railway, 123
McWhirter, W., tramway motors, 126*
M'William & J. O. Arnold, steel, 136A
Mailloux, C. O., traction curves, 320
Main and Dean, steam turbine, 605
Majorana, Q., wireless telegraphy, 1065
Makin, 608
Makower, W., sp. heat of steam, 1214A
Malengraux, superheating, 818*
Mallock, A., train resistance, 114*
Mann, C., power measurement, 1002
Mansfield, A.K., indicating, 146
Marchant, E. W., canal haulage, 944
de Marchena, governors, 446; railway, 917
Marchesini, telegraphic manipulator, 1068
Marconi, 1061
Marconi, G., wireless telegraphy, 812; magnetic detector, 1060A
Marillier, H. C., wireless telegraphy, 1064
Markovitch, G., motors, 195
Marsh, A. L., 992; battery deterioration, 991; light-weight battery, 990; storage-cells, 761
Marshall, A. C., F. W. Brooks, & W. O. Wood, railway, 209
Marshall, H. D., machinery protection, 464
Marshall, J. T., photometry, 717
Martin, S. S., 714
Martin, Saint-, 906
Marxen, H., indicator, 832A
Maskelyne, N., wireless telegraphy, 737
Mathieu, 30
Mathot, 151
Mathot, R., gas engine test, 673
Matthews, C. P., photometer, 576
Matthews, F. J. A., transmission, 228
Matthey, C. A., boilers, 608*
Mauermann, R., traction, 734
Maurain, C., magnetism of powders, 1251A
Mavor, H. A., 192; dynamo design, 884; motor control, 892*; tramway motors 126*
Mawdsley, H., St. Hill, commutation, 488
Max, 760
May, lubrication, 253*
Mayer, G. W., transformers, 903
Meier, H. D., lubrication, 31
Melville, 450
Méray-Rozar, 410
Mercadier, 442
Mercanton, P. L., frequency recorder, 737A
Merchese, 347
Merrill, F. E., railway, 210
Mershon, R. D., insulator pin, 1030
Meunier, P., motor testing, 894
Meyer, H. S., motors, 83
Meyersberg, G., load equalisation, 1034
Meynier, A., motor slip, 549
Michalowski, 990
Miesse, 963
Miller, *228*, 657
Milnes, 340
Minchin, G. M., wave detector, 1058A
Minerva, 751
Minet, *630*
Minet, A., & A. Neuburger, electric furnaces, 873
Minshall, T. H., high-speed plant, 956
Mitkiewicz, W., arcs, 89A, 90A
Mock, J. C., & W. E. Foster, signals, 514
Moebius, 347
Molet, 397
Mollier, W., motors, 196
Monarch, 148
Monash, B., arcs, 649A
Monath, L., networks, 659A
Moncrieff, Scott-, K. A., insulated lines, 45
Monroe, R. S., 909
Montagu, J. S., motor cars, 754
Montpellier, J. A., drainage, 179; mill plant, 653; telegraph posts, 950
Moody, V. D., alternators, 422
Morawetz, 534
Mordey, W. M., electric railways, 115*
Mordey, W. M., & B. M. Jenkin, traction, 710
Morgan, 836
Morgan, E, earthing, 94
Morris, D. K., engineering instruction, 65
Morrissey, 333
Mors, 972
Mossay, A., substations, 495
Moultrop, I. E., & R. E. Curtis, Edison station, 95
Mowbray, W. J., supply meters, 770
Muir, J., cooling and metals, 438A
Muirhead, 321, 1064

Digitized by Google

Mulhoux, A., carburettor, 13 ; lubrication, 162
Müllendorff, E., insulation faults, 908
Müller, F., motors, 1026
Müller, M., brakes, 129
Müller, W. A. T., alcohol as fuel, 829; automobile braking, 568 ; electromobiles, 569, 750
Multhauf, W., power station, 372
Munro, D. S., safety devices, 802
Munro, J., relay, 321
Munton, W. H., 571
de Muralt, C. L., *581 ;* traction, 122
Murray, 951
Murray, E. T. Ruthven, distribution, 91* ; generators, 70
Murray, T. B., motor control, 892*

Nagle, A. F., 147
Napier, 336, 978
Negreano, D., electrical separation, 1044A
Neiszen, J. H., rolling stock, 131
Nelson, J. B., power plant, 1038
Nernst, 226, 1054
Neuburger, A., alcohol motor, 11
Neuburger, A., & A. Minet, electric furnaces, 873
Newington, F. A., distribution, 91* ; earthing, 93*
Nicholson, 667
Niethammer, 634
Niethammer, F., generators, 189*
Nissl, F., telephony, 244
Noaillon, rotary fields, 784
Nodon, 695
Nodon, A., rectifiers, 1238A
Northrup, E. F., telegraphy, 597
Nowak, K., dynamo, 193
Nunn, P. N., C. H. Baker, L. Denis, H. J. Gille, & P. M. Lincoln, line protection, 439

O'Gorman, M., *246*
O'Hara, J. B., shipbuilding plant, 304
Olivetti, 999
Orde, E. L., liquid fuel, 394
Orlich, 535
Orlich, E., alternating currents, 1066A
Orsat, 608
Osnos, M., motor regulation, 548 ; motors, 493 ; rotors, 285
Osthoff, O. E., variable speed control, 628*
Otto, K., sag, 790
Oudry, 164
Outerbridge, A. E., heat-treatment of iron, 1011

Packard, 156
Packard, G. F., motor control, 545
Paets van Troostwyk, 767
Paillet, G., steering gear, 755
v. Paller, 829
Palmer, G. W., signals, 379
Park, W., schedule speeds, 930
Parke, R. A., 713 ; braking, 712
Parkes, 264, 469
Parkinson, G. R. J., governors, 447
Parshall, 283
Parsons, G. L., steam turbines, 983
Partridge, 59
Pascal, 975
Paterson, C., & A. Russell, switches, 57
Paul, G., surface contact, 433
Paweck, H., & W. Burstyn, voltametric balance, 1123A
Peck, J. S., transformers, 364
Peirce, B. O., magnets, 1250A
Pell, D. W., railroad, 561
Perkins, F. C., Bogota plant, 105 ; Brussels Station, 914; Hallau works, 941 ; hydraulic plant, 303 ; Romanshorn Station, 106
Perret, D., electric clock, 684
Perrine, F. A. C., transmission lines, 87
Perry, 709
Perry, J., water power, 86*
Perry, L. L., power factor, 555
Petavel, J. E., photometry, 718* ; standard light, 935
Petavel, J. E., & R. S. Hutton, electric furnaces, 768
Pfarr, 328 ; turbine, 44, 471
Pfatischer, 409
Pfitzner, W., electric ignition, 830
Pforr, P., traction problems, 221
Philip, A., copper refineries, 41
Phillips, E. F., Nernst lamp, 226*
Pichelmayer, K., commutation, 190
Picou, 634, 889
Picou, R. V., armature reaction, 79; permeameter, 831A
Pierard, E., dynamos, 640
Pierre-Guédon, L., motor coach, 976
Pigg, J., signalling, 1053
Pio, C., aluminothermy, 631
Piscicelli, Taezzi-, 934
Pochin, E. A. N., wireless telegraphy, 1066
Poetz, brakes, 127
McPoetz, brakes, 130
Pomeroy, L. R., shop driving, 531
Poole, C. O., power in mining, 355
Popplewell, W. C., smoke, 466
Potier, 634, 889, 902
Pott, A. H., 900
Powelson, W. V. N., voltage, 269
Preller, C. S. R., railways, 707
Prenzlin, P., commutation, 487
Prescott, 15
Price, W. A., 241
Probst, F., fuses, 876

Digitized by Google

Proctor, H. Faraday, distribution, 91*; earthing, 93
Pugliese, A., magnetic leakage, *841A*
Punga, F., commutation, 283
Pupin, 443
Pupin, M. I., 665; non-uniform conductors, 656A
Putnam, 657

Quin, 802

Raffay, Böhm-, B., dynamo, 69
Ramassot, 711
Ramsay, W., Miss H. Chick, & F. Collingridge, gutta-percha, 674A
Rankine, 958
Raphael, earthing, 93*
Rasch, M. G., tramway motors, 125
Rateau, A., condenser, 758
Raworth, J. S., smoke, 392
Raymond, E. B., technical training, 63
Rayner, E. H., dynamos, 78
Reber, S., army uses, 354
Reeve, S. A., Otto cycle, 859
Reich, W. I., F. Townsend, & H. P. Freund, alternators, 542
Reichel, W., locomotive, 315
Renard, 767
Rey, J., & A. Blondel, photometry, 225
Reynolds, O., & J. H. Smith, throw-testing machine, 1302A
Reyval, J., Harmet process, 398; type-forming, 410; works installation, 1044
Rhodes, 434
Ribourt, L., hydro-tachymeter, 882
della Riccia, A., Brussels plant, 497
Rice, A. C., turbines, 273
Richard, Georges, 966
Richards, J. W., aluminium, 630; electrical furnaces, 998
Richards, M. A., photomicroscopy of metals, 896A
Richardson, 531
Richmond, *846*
Richter, *1019*
Richter, C., galvanised iron, 869
Riedler, 181
Rigg, A., hydraulic relay, 358
Riley, J. C., governors, 390
Ringelmann, M., gas engines, 10
Robb, W. L., steam turbine, 145
Robbins, C. G., curved surface, 757
Roberts, 668
Robertson, C. H., 958
Robinson, L. S., light railways, 118
Rochefort, O., coherers, 475A
Rochet, 341
Rochet-Schneider, 969
Rodman, H., storage batteries, 903
Roessler-Edelmann, 264
Roman, J. M., synchronising, 76
Rontschewsky, 469
Rood, 718
Rood, O. N., high resistances, *349A*
Rosenberg, E., 1024; brakes, 54; paralleling alternators, 1023; wattless motor current, 689
Rosenhain, W., calorimeter, 395; platinum, 154A
Roser, 746
Rosset, G., ammonium chloride, 1291A
Rossi, 625
Rothert, 413, 634, 889
Rothert, A., commutation, 412
Rotth, A., magnetic leakage, 332A
Rousseau, 344
Routin, compounding generators, 885
Rowan, F. J., boilers, 608*
Rowe, 452
Rowland, 384
Rowland, H. A., 597
Roy, Le, 218
Rozar, Méray-, 410
Rülf, B., engine governing, 328
Runyon, F. O., factory plants, 1046
Rusby, J. H., Colorado plant, 794; power plant, 1040; tramway, 922
Russel, E., military cables, 385
Russell, A., & C. Paterson, switches, 57
Ruthenburg, M., steel production, 769
Ruthven Murray, E. T., distribution, 91*; generators, 70
Ryan, 287, 540
van Rysselberghe, 663

Sadtler, S. S., electrolytic reduction, 995
St. Hill Mawdsley, H., commutation, 488
St. Lindeck, manganin low resistances, 1234A
Saint Martin, 906
Salamandrine, 337
Salamonson, I. K. A. W., arcs, 463A
Salazer, 802
Salom, P. G., lead, 1118A
Salter, J. R., converters, 292
Salvadori, R., postal system, 934; undulatory currents, 887
Samojloff, A., 549
Santos-Dumont, 33, 980
Sartiaux, 222
Sauveur, A., rails, 135
Sauveur, A., & H. C. Boynton, structure of steel, 1012
Sayers, W. B., motor control, 892
Schaefer, C. W., testing, 170
Scheurer-Kestner, 252
Schiemann, M., trolley wire, 510
Schimanek, E., oil engines, 748
Schmer, 181
Schmidt, 667

Digitized by Google

Schmidt, H. F., economisers, 388; liquid fuel, 986
Schmidt, J., switches, 352
Schneider, Rochet-, 969
Schönau, W., cable disturbances, 519
Schoolbred, J. N., distribution, 91*
Schoop, 764
Schoop, M. U., accumulator tests, 863; battery deterioration, 992
Schorr, R., fuels, 393
Schöttler, R., alcohol engines, 851
Schreber, K., multi-vapour engines, 813A
Schröter, 666, 818
Schuckert, 117, *239*, 569
Schuh, H., railway lighting, 227
Schüler, 506, 549
Schüppel, W., heating of machines, 787
Schwarz, A., motors, 290
Schwirkus, R., & H. F. Wiebe, springs, 746
Scott, generators, 70*
Scott, C. F., 365; American Institute of E. E. 281
Scott, E. K., large dynamos, 896
Scott-Moncrieff, K. A., insulated lines, 45
Sederholm, 529
Seibt, G., 549; electric waves, 1077A; resonance, *1082A*
Selby-Bigge, D., power, 178
Ser, 252
Service, G., mill engine balancing, 678
Sever, G. F., 175; elevators, 51
Sewell, J. S., submarine mines, 536
Seyfferth, A., fender, 508
Sharp, A., motor waggons, 749
Sharp, C. H., photometry, 791A
Sharpy, C., steel, *848A*
Shawfield, C. E. C., Lorain system, 1049
Sheffield, T. W., tramway management, 731
Sheldon, S., electrochemical industries, 187; engineering courses, 62
Shepardson, G. D., train lighting, 940
Sidler, A., railway, 916
Siemens, 347, 477, 533, *944*
Siemens, A., 114; traction, 710*; metrical system, 950A
Simpson, R. H., rolling stock, 593
Slaby, 746
Sleeper, 326
Slichter, W. I., alternators, 416
Smith, Holroyd-, M., electric railways, 115*
Smith, Howard-, W., rail sections, 926
Smith, J. H., & O. Reynolds, throw-testing machine, 1302A
Smith, R. H., train resistances, 114*
Smith, W. S., turbines, 168
Snell, J. F. C., distribution, 91; high-tension continuous-current, 89*
Sniffen, E. H., steam turbine, 263
Solari, L., wireless telegraphy, 736
Solignac, 250
Somach, H., Rodez tramways, 562
Soschinski, B., iron-testing, 1006
Spence, W. G., 608
Spence, W. L., motor control, 892*
Spencer, 836
Spencer, C. J., brakes, 128; power stations, 907
Sperry, E. A., train lighting, 948
Spilberg, A., armature reaction, 778; tramway tyres, 927
Stanley, E., oil fuel, 333
Stanley-Kelly, 418
Stannon, 265
Stanton, L. W., telephony, 247
Stanton, T. E., flow of water, 531A
Stassano, 878
Stead, J. E., steel and alloys, 1480A
Steiger, A., water power plants, 706
Steinhart, 347
Steinmetz, 597, 1022
Steinmetz, C. P., 421; power consumption of electric elevators, 175*; railway, 654*; surges, 88*; training of engineers, 64; mercury arc, 1225A
Stern, G., meter, 350
Stevens, E. M., railway, 915
Stewart, A., supply costs, 1033
Sthénos, 346
Stirling, 5
Stodala, 328
Stodola, A., steam turbines, 815
Stone, 222
Storer, N. W., three-wire system, 543; variable speed control, 627*
Stott, H. G., steam pipes, 391
Stovel, R. W., power, 46
Strecker, telephone lines, 598*
Stribeck, 816
Stribeck, R., 458; bearings, 745
Stromeyer, C. E., boilers, 607; boilers, 957
Strymeersch, train lighting, 222
Sugden, 448
Sumec, J. K., induction motor, 789
Sutcliffe, W. L., mechanical draught, 330
Swift, 339
Swinburne, 347, *640*
Swinburne, J., 783; engineering limits, 772; traction, 710*
Swinburne, J., & W. R. Cooper, electric railways, 115
Swinton, A. A. Campbell, electric railways, 115*
Sykes, F. G., tramways, 502
Szasz, G., canal haulage, 933

Digitized by Google

Taeggi, 220
Taeggi–Piscicelli, 934
Talbot, E., C. Hopkinson, & B. Hopkinson, tramways, 709
Tatlow, W., water power, 86
Taveau, A., transporters, 218
Taylor, A. H., wireless receiver, 1064A
Taylor, E. R., 400; electric furnaces, 1017
Taylor, F. A., 952
Taylor, J. E., earth-currents, 1221A
Tesla, 879
Thieme, P., accumulator-switch, 680
Thomas, P., 876
Thomas, P. H., 88; lightning, 173
Thompson, 540
Thompson, H. E., gas engines, 958
Thompson, S. P., 241, 665; dynamo design, 192; electric railways, 115*
Thomson, W., boilers, 608
Thonet, brakes, 130*
Thonet, C., central stations, 113
Thornycroft, 621
Thum, F. A., 865
Thurso, J. W., turbines, 470, 771
Thurston, 816
Thurston, R. H., "heat-waste" engines, 985
Thury, 89
Timmis, S. A., train resistance, 114*
Tissot, C., 1061
Tittensor, W. H., distribution, 91*
Toledo, 153, 857
Tolle, 328
Tommasi, 347; accumulator, 626
Tommasi, D., accumulator, 685
Tompkins, P. W., impurities in crude petroleum, 670
Tony Huber, 834
Torres, 34
de la Tour, Boy, 784; alternators, 780; Heyland's motor, 82; induction motor, 782
Tower, 816
Tower, B., 253
Townley, C., braking, 712*
Townsend, F., H. P. Freund, & W. I. Reich, alternators, 542
Trantweiler, M. A., car sheds, 132
van Troostwyk, Paets, 767
Trotter, A. P., distribution, 91*; earthing, 93*; tramways, 709*
Troynam, 347
Turpain, A., wireless telegraphy, 1061; Hertz resonator, 672A; lightning, 247A
Tuttle, D. K., refining gold, 623
Tyrell, A. A., 699

Ulbricht, R., drop in rails, 583
Ulke, T., copper refining, 867; electrolytic separation, 994; lead refining, 348; nickel refining, 865
Uppenborn, 863
Uppenborn, F., 552

Valentin, E., lorry, *861*
Van der Stegen, A., superheating, 818
Vandeuren, P., wire tension, 523
Vanoni, L., telephone exchange, 739
Varley, 321
Vellguth, H., railway practice, 141
Verhoeckx, P. M., double-current generators, 1022
Vetéran, Decauville car, 835; locomobile, 163
Vicarino, 222
Vinçotte, 818
Violle, 225
Vivian, 865
Vogelsang, M., cut-outs, 351
Voigt, 351, 837
Voigt, H., switches, 401

de Waal, H., batteries, 556
Wagener, A., indicators, 825
Wainford, R. H., mining appliances, 407
Walch, E., power transmission, 1032
Walcker, 620
Walker, 971
Walker, E., hypochlorite cell, 399
Walker, S. F., earthing, 93*
van der Wallen, steel works, 652
Walsh, G. E., electric control, 803
Ward, 479
Ward Leonard, 710
Ward Leonard, H., multiple unit, 567; variable speed control, 627*
Wardburg, 21
Warren, J. W., fuel, 150
Waverley, 1052
Webb, F. W., traction, 710*; train resistance, 114*
Webster, 467, 657
Wedding, 1054
Wedding, W., arcs, 380
Weill, 164
Weiss, F. J., condenser, 454
Weissmann, 936
Wellner, G., balloons, 858
Westberg, N., gearing, 174
Western, R. W., stopping costs, 566
Westinghouse, 712
Weston, 16
Westphal, C., alternators, 71
Wheeler, 455
Whitman, 718
Wiebe, H. F., & R. Schwirkus, springs, 746
Wien, M., analogy, 658A; resonance, 1083A

Digitized by Google

Wike, C. F., tramway maintenance, 121 ; tramways, 219
Wilde, 164
Wilder, F. A., lignite fuel, 669
Wilke, A., wireless telegraph station, 1062
Wilkens, lubrication, 253*
Wilkens, K., "earthing," 552
Williams, *880*
Williams, A., variable speed control, 627*
Williams, E. T., ozone, 468
Williston, A. L., liquid fuel, 987
Wills, R. L., hysteresis loss, 1070A
Wilson, 392
Wilson, Carus-, C. A., electric railways, 115* ; train resistance, 114*
Winawer, F., & C. Bender, cranes, 485
Winchell, W., 334
Wingfield, C. H., liquid fuel, 394*
Winter, G., regulation motors, 1027
Wirt, H. C., voltage regulation, 699
Wischnegradsky, 328
Wittenstrom, 264
Wohlwill, 623
Wolcott, T., cable testing, 349
Wood, W. O., F. W. Brooks, & A. C. Marshall, railway, 209
Woodbury, 816
Woodfield, S., generators, 286 ; rails, 238
Woodhouse, W. B., Newcastle Station, 425 ; pressure rises, 231 ; turbo-alternators, 461
Woodward, 682
Wordingham, C. H., generators, 70* ; high-tension continuous-current, 89*
Wurts, A. J., Nernst lamp, 226*
Wydts, 936
Wyssling, Lausanne transmission, 726

Yarrow, 611
Yorke, 927
Young, J. E., submarine cables, 952

Zacharias, J., storage cell, 537
Zeidler, J., arc lamps, 804
Zehnder, L., electric waves, 745A
Ziegler, M., and H. le Chatelier, iron sulphide, 1093A
Ziehl, asynchronous generators, 288* ; generators, 287*
Ziffer, E. A., traction systems, 117
Zimmerman, 763
Zipernowsky, K., lighting, 936

Digitized by Google

SUBJECT INDEX.

SECTION B.—ELECTRICAL ENGINEERING.

To facilitate reference to any desired subject, the Index is divided into the following sections arranged alphabetically. If any of these are absent this may be taken as an indication that no Abstracts dealing with those particular subjects have been included in this volume.

The numbers refer to Abstracts, those in italics referring to References.

An asterisk indicates remarks in a discussion.

In Steam Plant, Gas and Oil Engines:—Accessories (steam plant); Automobiles; Boilers; Condensers, Economisers, Feed Water Heaters and Superheaters; Gas Engines, Gas Producers, &c.; Miscellaneous; Oil Engines; Steam Engines; Air-ships and Balloons.

In General Electrical Engineering:—Accessories and Appliances (electrical, excluding traction); Apparatus and Instruments (descriptive); Batteries (primary); Batteries (secondary); Equipment of Factories and Mines; Insulation and Insulators. Machine Tools, Cranes and Elevators, &c.; Materials of Construction, their properties and treatment; Metallography and Treatment of Metals; Miscellaneous Water-power Plant.

In Generators, Motors, and Transformers:—Alternators; Dynamos; Miscellaneous; Motors; Rectifiers; Transformers and Rotary Converters.

In Power Transmission, Traction, and Lighting:—Accessories and Appliances (traction); Automobiles; Cables, Conductors and Wiring; Costs; Electricity and Traction Works (descriptive); Lamps (arc) and Arc Lighting; Lamps (incandescent); Miscellaneous; Power Transmission and Distribution; Traction (electric, by accumulators); Traction (excluding accumulator traction and descriptions of power stations); Traction (mechanical).

In Telegraphy and Telephony:—Telegraphy (excluding wireless telegraphy); Telegraphy (wireless); Telephony.

Supplementary Index of Works and Installations described in this Volume, p. 501.

Abstract Nos.

Accessories and Appliances (Electrical, excluding Traction).

Circuit-breaker for Induction Motors. A. Bianchi 636
Circuit-Breakers, Operation of Automatic, and the Effects of Short Circuits on Dynamos. B. Hopkinson 532
Clothing for High Voltages, Protective. N. Artemieff 879
Cut-outs and Switches, Voigt and Haeffner's Electromagnetic. M. Vogelsang 351
Cut-out, Ferranti Patent Voltmeter Resistance 271
Fuse, Experiments with an Extra High-Tension. C. C. Garrard 877
„ The Partridge Sparklet 59
Fuses for High-tension Mains. F. Probst 876
„ , Uninterchangeable. R. Hundhausen *1016*
Insulator Pin, Specifications for Proposed Standard. R. D. Mershon 1030
Oil-break Switches, High-tension 1003
Resistances for Large Currents, Iron Wire. F. Loppé 58
Rheostats, Field. R. Krause *80*
„ „ , for Shunt-wound Dynamos, Design of. G. J. Erlacher 67
Speed-Indicator, Highfield and Beeton 56
Switch, Accumulator-, Non-Sparking. P. Thieme 680
Switchboards for High Pressures. Benischke 875

Digitized by Google

Abstract Nos.

Accessories and Appliances (Electrical, excluding Traction), *continued.*
Switches and Fuses, Testing Alternate Current. G. W. Howe..... 1005
„ , Automatic Transformer. J. Schmidt 352
„ High Insulation. H. Voigt 401
„ Sparking in. A. Russel and C. Paterson 57

Accessories and Appliances (Steam Plant).
Indicator, Hospitalier's *981*
Indicator Springs, Testing. H. F. Wiebe and R. Schwirkus 746
„ „ „ E. Förster 826
Indicators, Engine, Improvements in. A. Wagener 825
Lubricator, Automatic *161*
Meter, Power- 147
Separator, Harris-Anderson Oil..... 614
Stop and Speed Limit, Monarch Engine- 148
Stopping Devices, Engine Safety. J. F. Hobart *36*
Valve, Reducing *679*

Accessories and Appliances (Traction).
Block System of Middleboro' and Buzzards Bay Street Railway 573
Brakes, Electric. M. Müller..... 129
„ „ G. H. Fawcus 223
Brakes for Tramcars. C. J. Spencer 128
„ , Tramway. Poetz, Thonet,* G. Koehler,* von Leiber * 130
Brake Systems on Electric Tramcars 127
„ Tests and Deductions therefrom. J. D. Keiley..... 655
„ Trials, Pneumatic..... 434
Braking and Brake Tests. T. P. Gaylord,* J. R. Cravath,* E. B. Clark,* B. J. Arnold *..... 713
Braking, Railroad Car. R. A. Parke, C. Townley,* W. O. Gotshall * 712
Fender for Electric Cars, Grampe's. A. Seyfferth 508
Signal Circuits, Railway. J. C. Mock and W. E. Foster..... 514
Signalling, Automatic, for the Block System and Car-spacing Device 224
Signalling for Railways, Electric 572
„ , Modern Electric Block. E. F. Bliss 138
„ Railway Block. J. Pigg..... 1053
„ Railway, "Crewe" System of 378
„ Railway, Putnam & Webster and the Miller Automatic Electric Block Systems of. L. Kohlfürst 657
Signals, Automatic Block, on the Liverpool to Manchester High-Speed Railway. L. Kohlfürst 137
„ Block 513
Signals for Urban and Interurban Railways. G. W. Palmer 379
„ , Semaphore, on Bristol Electric Tramways. C. Challenger... 571

Air Ships and Balloons.
Accidents, Recent Aeronautical. G. Espitallier 845
Aeroplanes, Experiments with. L. Fournier..... 844
Air Navigation. C. Chavontier..... 33
Automobile Balloons. G. Wellner *858*
Greth Airship. A. Inkersley 980
Torres Dirigible Balloon..... 34

Alternators.
Armature Reaction and Hunting of Polyphase Generators. R. Goldschmidt 541
Armature Reaction of Alternators. C. F. Guilbert 634
Armatures, The Heating of Toothed-Core. F. W. Davies..... 191
„ The Impedance of Alternator. F. Townsend, H. P. Freund, and W. I. Reich..... 542
Armature Windings. W. Kübler *197*
Asynchronous Generators. Görges,* Eichberg,* Ziehl,* Heyland*... 288
„ „ , Excitation of, by Means of Condensers. A. S. McAllister *897*
Asynchronous Machines, Compensated and Compounded. A. Heyland *898*

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Alternators, *continued.*
Asynchronous Polyphase Generator. L. Gratzmuller 419
Compounded and Compensated Asynchronous Alternating-current Machines. A. Heyland 781
Compounding Alternators. Boy de la Tour 780
„ Electric Generators, Electromechanical Governing and. Routin 885
Compounding Generators and Niagara Falls Plant *319*
Commutation, Sparkless. F. Punga 283
„ „ J. Freund 413
„ Theory of. K. Pichelmayer 190
„ „ A. Rothert 412
Commutators and Slip-rings. R. Hellmund 414
Design, Notes on Alternator. J. Denham 417
Design of Polyphase Machines. D. Bergman 490
„ of Special Types of Generators. Bauch,* Görges,* Kübler,* R. Braun,* Niethammer * 189
Double-Current Generating Sets. F. Collischonn 890
„ „ Generators. P. M. Verhoeckx 1022
„ „ „ and Rotary Converters. S. Woodfield 286
Drop, P.D. of Alternators, Calculation of. C. Westphal 71
Drop, Voltage, in Alternators. F. Kesselring 415
„ Voltage, of Alternating-Current Generators, Calculation of. V. D. Moody *422*
Engine Speeds for Direct-connected Alternators. E. Knowlton 72
Exciters, Compensating, Alternators with. Boucherot 75
Field Distortion and Armature Reaction. R. Bauch 284
Fields, Alternator, The Normal Saturation of. R. Beattie 74
Flywheel capacity of Engine-driven Alternators. W. T. Slichter ... 416
Frames of Alternators. H. Böhmländer 194
Gramme Ring, Theory of. K. R. Johnson 1244A
High-speed Electrical Generating Plant. T. H. Minshall 956
Manufacture of Large Dynamos and Alternators. E. K. Scott *896*
Induction Alternators, Self-exciting. A. Heyland, Boucherot,* Latour * 73
Parallel Running, Engine Governors for. G. R. J. Parkinson 447
„ Running of Alternators. G. Benischke 888
„ „ „ H. Görges 1024
„ „ „ , Action of the Engine Governor in. de Marchena 446
„ Working of Gas-Engine driven Alternators. E. Rosenberg. 1023
Pressure on a Three-phase Generator, Rise in. F. Finckl 779
Separately Excited Machines, Regulating Rheostats for. C. Kinzbrunner 891
Single-phase Alternators on Polyphase Circuits *296*
Standardisation of Specifications Relating to Generators and Transformers. G. Dettmar 360
Stanley-Kelly Alternate-current Generator 418
Synchronising, Notes on. J. M. Roman 76
Testing of Alternators. F. Loppé 889
Three-phase Alternator, 500-kw. *295*
Turbo-Alternators. W. B. Woodhouse *461*
Waves, Alternator, Elimination of Harmonics from. C. F. Guilbert 104A

Apparatus and Instruments (Electrical, Descriptive).
Ammeter for Large Currents 477A
Ammeters, Hot Wire. Kollert 478A
Apparatus, Graduation of. Arcioni *700A*
"Arcs," Singing. I. K. A. Wertheim Salomonson 463A
Current Indicator, Registering Maximum. H. Marxen 832A
Currents, Measuring very Large Alternating. Iliovici and P. Janet ... 1245A
Curve-tracing Instrument *932A*
Demand Indicator, Fricker's Maximum 1000

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Apparatus and Instruments (Electrical, Descriptive), *continued.*

Electrograph, Improved 445
Frequency Recorder. P. L. Mercanton 737A
Galvanometer, Recording, and Rotating Contact-Maker. J. Carpenter 1239A
Interrupter, Current. C. F. Jenkins 1240A
Magnetic Measurements, Industrial. Armagnat 934A
Magnetometric Method, Errors in. V. Erhard 741A
Meter, Alternating-current. G. Stern 350
„ Aron Energy. M. Aliamet 632
Meters, Energy (Aron System), Methods of Testing. M. Aliamet ... 535
Meters for Three-phase Systems with Four Wires 483
„ , Motor. T. Bruger 266
Milameter and Galvanometer for Cable Testing. C. W. Schaefer ... 170B
Novelties in Electrical Apparatus, Some. M. B. Field 277
Oscillographs, Recent. A. Blondel 840A
Permeameter, Universal. R. V. Picou 831A
Phasemeter, Rayleigh's Alternate Current. E. S. Johonnott 738A
Photometer for Incandescent Lamps, Integrating. C. P. Matthews 576
„ Incandescent Lamp 383
Potentiometer, Combined Sliding-Contact and Plug Switch for, and other Resistances. M. Edelmann 830A
Quantometer, Electric. R. Beattie 736A
Relay, Muirhead's Cable. J. Munro 321
„ Polarised. K. G. Frank 1262A
Resistance Standards, Low-, Constancy of Manganin, in Practical Use. St. Lindeck 1234A
River Gauge, Electrical. J. F. Barnes 775
Synchroniser, Rotary 687
Telephonic Receiver for Wireless Telegraphy. L. Bleekrode 322
Voltametric Balance, New. H. Paweck and W. Burstyn 1123A
Voltmeter, Pocket. J. A. Montpellier 833A
Voltmeters, Rapidly Calibrating, Apparatus for. F. A. Laws and W. D. Coolidge 256A
Wattmeter, Olivetti Recording. A. Bainville 999

Apparatus and Instruments (Non-Electrical).

Balance, Electro-hydraulic. W. Hentze 169
Calorimeter, Improved Coal. W. Rosenhain 395
CO_2 Recorder, "Ados" 254
Extensometer, Roller. G. C. Henning 289A
Governor, Hydraulic, with Relay 402
„ Woodward Water-wheel 682
Hydraulic Relays and Governors. A. Rigg 358
Hydro-Tachymeter. L. Ribourt 882
Load-Strain Recorder for Test Specimens, Autographic. Goodman 695A
Lubricating Oils, Machine for Testing. G. Dettmar, Arnold,* May,* Wilkens,* Haas* 253
Planimeter, Bryan 689A
„ Theory of. W. J. Tennant 992A
Pressure Regulator. W. K. Hatt 146A
Pyrometer, Optical. L. Holborn and F. Kurlbaum 1196A
Slide Rule, Hazen and Williams' Hydraulic 880
Turbidimeter. C. Anthony, Jr 1130A

Automobiles (Electrical).

Benzine-Electromobiles. W. A. T. Müller 750
Braking, Recuperative, of Electric Automobiles. W. A. T. Müller... 568
Carrier-Tricycle, Arendt Electrical. E. Dieudonné 800
Hart Petrol Electric Car, 40-H.P. 973
Launches, Electric. C. Dreihardt 570
Schuckert Co.'s Postal Delivery Electromobile. W. A. T. Müller ... 569
Waverley Electromobiles 1052

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Automobiles (for Oil and Steam Engines, *see* separate sections).
Aultman Lorry and other American Steam Lorries 836
Bearings, Plain and Roller. R. Stribeck 745
„ Steel Ball 458
Benz "Parsifal" Petrol Car 967
Boats, Motor, using Producer Gas. K. Bräuer 843
Boilers, Flash. J. S. V. Bickford 449
Brouhot Car. L. Fournier 753
Chaboche Steam Car 964
Charron-Girardot-Voigt Car, 15-H.P. L. Fournier 837
Chatel-Jeannin, Petrol Car 24
Chenard and Walcker Petrol Car 620
„ „ 14-H.P. Petrol Car 971
Clément Light Car. L. Fournier 152
„ Voiturette. L. Fournier 855
Columbia Petrol Voiturette. D. Bellet 28
Continental Petrol Cars 970
Crouan Petrol Car 965
Darcelle Petrol Car 833
Darracq 12-H.P. Car M. Chérié 343
Dietrich-Bugatti Petrol Car 968
de Dietrich Car 22
Decauville Cars: 1903 Type, 16-H.P. Vétéran 835
Delahaye Cars with Vertical Motors 752
Denis Steering Gear. G. Paillet 755
Earl Petrol Cars 619
Electromobiles, Benzine-. W. A. T. Müller 750
„ Waverley 1052
Fire Engine, Auto-benzine 675
Fischer Gasoline-Electric Truck 154
Franklin Light Roadster 27
Friedman Light Car 25
Fuel for Motors, Comparison of Benzine and Alcohol as. W. A. T. Müller 829
Garreau Motor-Bicycle 974
Gear, Simplex Variable Speed 840
Georges Richard Car, 15-H.P. L. Fournier 966
Germain Electric Change-Speed Gear 622
German Lorry with Direct-driven Rear-axle. E. Valentin 861
Hansen Gasoline Carriage 155
Hart Petrol-Electric Car, 40-H.P 973
Hautier Petrol Cars 832
Henriod Cars 19
Hewetson Motor Bicycle 342
Humber Motor Bicycle 29
Ignition, Electric, Function of Auxiliary Spark-gaps in. W. Pfitzner 830
Ivel Agricultural Motor 26
Klingenberg Car 20
Launches, Automobile, Power of. F. Forest 345
Locomobile Car. Vétéran 163
„ Steam Cars 618
"Long-distance" Touring Carriage 23
Lorries, Recent German 21
Lorry, Novel Steam 18
„ Steam Motor 17
Lubrication, Graphite, for Automobiles. H. D. Meier 31
„ Motor-Car. T. Clarkson 841
Miesse Steam Car 963
Milnes Voiturette 340
Minerva Cars 751
Mors Car 972
Motor Manufacturing Company's Cars 338

For the **Explanation** of this **Index** see p. 471.

Digitized by Google

Abstract Nos.

Automobiles (for Oil and Steam Engines, *see* separate sections), *continued.*
Municipal Motor Wagons. A. Sharp 749
Nice Speed Races 838
Pascal Car 24-H.P. M. Chérié 975
Prescott Steam Car 15
Pulley, Delagneaux Extensible. L. Fournier 839
Railways, Light Petrol Cars on. L. Pierre-Guédon 976
„ Motor Cars as Feeders to. J. S. Montague 754
„ Steam Motor Coaches on 977
Rochet-Schneider Petrol Car 969
„ Voiturette. L. Fournier 341
Rousseau Car 344
Speed-indicator, Highfield and Beeton 56
Steering Gear, Mathieu 30
„ „ Napier 978
Swift Voiturette 339
Tests of Cars, Reliability 100-Mile 457
Thornycroft Petrol Cars 621
Tony Huber 20-H.P. Petrol Motor 834
Toledo Gasoline Touring Car, Transmission Gear of 857
„ Touring Car 153
Traction, Mechanical Road. A. E. A. Edwards 39
Traction of Road Vehicles 853
Transmission Arrangement, Cardan-, Legros 842
Vulcan Trembler for Ignition Coils 831
Weston Steam Cars 16

Batteries (Secondary).
Edison Storage Battery. H. F. Joel 43
Control, Speed, Storage Battery as a Factor in. H. B. Coho 480
Curves, Storage Battery. C. Hering 530
Heinicke's Storage Cell. J. Zacharias 537
Light-weight Storage Battery, Possibilities for. A. L. Marsh 990
"Max" Accumulator. J. J. Heilmann 760
Output of Lead Storage-cells. A. L. Marsh 761
Pasted Electrodes for Accumulators. E. Leimer 864
Plates, Accumulator. E. Leimer 989
„ Storage Battery, Deterioration of. A. L. Marsh 991
„ „ „ M. U. Schoop 992
Regulating Batteries, Connections of. H. de Waal 556
Storage Batteries. H. Rodman 993
Tests, Accumulator. M. U. Schoop 863
Tommasi Accumulator. Tommasi 626
„ „ D. Tommasi 685

Boilers.
Choice of Steam Boilers. C. E. Stromeyer 957
Draught, Mechanical, for Boilers. W. L. Sutcliffe 330
Economy, Boiler. E. S. Farwell 820
Explosion, Boiler. C. Bach 744
Explosion of Steam Boilers, Causes of, and Means of Prevention. J. Fournier 6
Explosions, Boiler. C. Bach 984
Externally-fired Boilers. W. H. Fowler 606
Flash Boilers. J. S. V. Bickford 449
Furnaces, Efficiency of Boiler. C. E. Stromeyer 607
Hohenstein Water-Tube Boiler 450
Management and Working of Steam Boilers. W. H. Fowler 463
Marine Boiler, Stirling 5
„ Water-Tube Boilers. H. C. Dinger 821
Naval Boilers, Report of the Committee on 4
„ Boiler Tests. J. Halligan 822
Salamandrine Boiler 337
Scale, Conductivity of Boiler, &c. W. E. Ernst 743

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Boilers, *continued.*
Sederholm Boiler 529
Shell Boilers, Circulation in. W. Thomson, S. Couper*, F. J. Rowan*, C. A. Matthey* 608
Solignac Boiler. W. H. Booth 250
Stayed Surfaces, Curved, Strength of. C. G. Robbins *757*
Stoking and Hand Firing, Comparative Economy of. J. Geldard ... *759*
Sugden Water Tube Boiler 448
Trials of a Steam Boiler with Three Internal Flues. L. Lewicki 742
Tubular Boilers for 400-h.p., Horizontal Return 3
Water-tube Boiler, Roberts' 668
„ Boilers 251
„ „ in American Mercantile Marine. W. A. Fairburn *396*

Cables, Conductors, and Wiring.
Cable, Anglo-Belgian Telephone. Leduc 813
„ Proposed Non-Inductive. C. E. Fritts 241
„ Submarine, for the Mexican Government 518
Cable System of the Philippines, Military. E. Russel 385
„ Testing, The Milameter and Galvanometer for. C. W. Schaefer 170
Cables, Disturbances on Underground Telegraph. W. Schönau 519
„ Long Submarine, Resistance and Capacity in. J. E. Young 952
„ Standardisation of 791
Droop and Tension in Wires. H. v. Glinski 1029
Insulated Lines in India. K. A. Scott-Moncrieff 45
Multiple-Wire Systems, Measurement of Insulation Faults in. E. Müllendorff 908
Networks of Conductors, Substitution Method of Treating Problems Regarding. L. Monath 659A
Overhead Lines, Mechanics of. Brunhes *1058*
Sag in Overhead Conductors. K. Otto 790
Spans, Overhead Wire. K. Krohne *318*
Stranding of Conductors. P. Holitscher *272*
Subway and Outfall Sewer, Aberdeen Cable. G. R. G. Conway *589*
Telephone Lines. G. A. Campbell 953
„ „ , Disturbances on. P. M. Lincoln 954
Tension of Telephone Wires, Variation of. P. Vandeuren 523
Transmission Lines, Electric. A. D. Adams 901
„ „ Long-distance, Protection of. F. A. C. Perrine 87
Wave Propagation over Non-uniform Conductors. M. I. Pupin 656A
Wiring Rules of the Institution of Electrical Engineers *805*

Condensers (Steam).
Balcke Condensing Plant at Düsseldorf 331
Ejecto-condenser. A. Rateau *758*
Intensifier, Vacuum 615
Jet Condensers with Auxiliary Water-vessels. F. J. Weiss 454
Surface Condenser and Cooler, Combined 528
„ Condensers, Richmond's and Brown's *846*
Wheeler Water-cooling Tower 455

Costs.
Boiler Economy. E. S. Farwell 820
California and Virginia Mining Co., Nevada, Electrical Equipment of the Consolidated. L. M. Hall 215
Central Station Charging Systems and Rates in Use in U.S.A. 299
Charging for Electric Energy, Methods of. P. Lauriol 557
Distribution, Two *versus* Three-wire. J. F. C. Snell, E. T. Ruthven Murray,* F. A. Newington,* R. A. Chattock,* J. N. Schoolbred,* J. S. Highfield,* V. A. H. McCowen,* W. H. Tittensor,* H. Boot,* A. P. Trotter,* H. F. Proctor* 91
Engines, Economy of Marine Screw. E. Hall-Brown *676*
Factory Lighting Plants, Economy of. F. O. Runyon 1046
Lighting, Street, in New York and the Proposed Municipal Plant ... 909

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Costs, *continued.*

Mining, Quartz, Economy of Electric Power in. C. O. Poole 355
Power, Cost of. M. J. Eichhorn *229*
Power for Electricity Works, Steam *v.* Water. A. Hecker 701
„ Station Working. A. L. C. Fell 85
„ Stations, Central, in Europe. L. Gerard 906
„ Transmission, Cost of Electric. A. D. Adams *515*
„ Transmission in the Department of Aude, France 200
Railway System, Street, Pittsburg 923
Railways, Electric. J. Swinburne and W. R. Cooper, W. E. Langdon,* W. M. Mordey,* S. P. Thompson,* C. A. Carus-Wilson,* P. V. McMahon,* W. Geipel,* A. A. Campbell Swinton,* M. Holroyd-Smith* 115
„ Electric Suburban. E. A. Evans 120
„ Light, Narrow *versus* Ordinary Gauge on. C. de Burlet, L. S. Robinson,* L. Janssen* 118
Stoking and Hand Firing, Comparative Economy of. J. Geldard ... *759*
Substation Equipment and Transmission Line, Influence of, on the Cost of Electricity Supply. A. Stewart 1033
Supply Works Costs, Electricity *1060*
Traction, Central Stations for. C. Thonet 113
Train Lighting. Strymeersch 222
Tramcars and Trains, Cost of Stopping. R. W. Western 566
Tramway System of Bolton 564
Tramways, Dublin Electric 109
„ Notes on the Wear and Maintenance of. C. F. Wike ... 121

Dynamos.

Armature Core Discs for Continuous-current Machines. F. W. Davis *293*
„ End Connections, Drum. J. Dalemont *639*
„ Interference and Brush Position. H. M. Hobart 486
„ Plates, Toothed, Manufacture of. R. Hundhausen *641*
„ Reaction, Field Distortion and. R. Bauch 284
„ „ Predetermination of. R. V. Picou *79*
„ „ Reducing. A. Spilberg 778
„ Windings. W. Kübler *197*
Armatures, The Heating of Toothed-Core. F. W. Davies 191
Brushes, Carbon, Contact Resistance of. Bourguignon, Hospitalier,* Gratzmuller,* Brunswick,* Girault* 633
Commutation. H. St. Hill Mawdsley 488
„ , Sparkless. P. Prenzlin 487
„ „ F. Punga 283
„ „ J. Freund 413
„ „ E. Dick *84*
„ Theory of. K. Pichelmayer 190
„ „ A. Rothert 412
Commutators and Slip-rings. R. Hellmund 414
Compensated Continuous-Current Generators. F. Eichberg, Arnold,* Ziehl* 287
Compounding Continuous-Current Dynamos for Variable Speeds, Methods of. F. Loppé 411
Compounding Dynamos for Train-Lighting, Loppé's System of. P. Letheule 489
Compounding Electric Generators, Electromechanical Governing and. Routin 885
Compounding Generators and Niagara Falls Plant *319*
Design, Dynamo, The Specific Utilisation of Materials in. S. P. Thompson 192
Design of Continuous-Current Dynamos. H. A. Mavor, M. B. Field,* W. A. Ker,* W. B. Hird* 884
„ of Dynamos. E. Korrodi 538
„ of Special Types of Generators. Bauch,* Görges,* Kübler,* R. Braun,* Niethammer* 189

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Dynamos, *continued.*
Double-Current Generating Sets. F. Collischonn 890
„ Generators. P. M. Verhoeckx 1022
„ „ E. T. Ruthven Murray, C. H. Wordingham,* W. B. Esson,* L. Andrews,* Scott* 70
Double-Current Generators and Rotary Converters. S. Woodfield... 286
Efficiency, Dynamo, Determination of. J. R. Ashworth..... 361
Efficiency of Dynamos, Methods of Testing. E. Pierard *640*
Field Magnet, Dynamo with Internal 539
„ Rheostats, Calculation of. E. Dick *298*
„ Rheostats for Shunt-wound Dynamos, Design of. G. J. Erlacher 67
Flywheel Dynamo. K. Nowak 193
High-Speed Electrical Generating Plant. T. H. Minshall..... 956
Leakage, Measurement of Magnetic. A. Rotth..... 332A
Manufacture of Large Dynamos and Alternators. E. K. Scott *896*
Self-excitation of Dynamos. L. Finzi 777
Separately Excited Machines, Regulating Rheostats for. C. Kinzbrunner 891
Short Circuits, The Operation of Automatic Circuit-Breakers and the Effects of, on Dynamos. B. Hopkinson 532
Standardisation of Specifications Relating to Generators and Transformers. G. Dettmar 360
Steam Dynamos, Testing. E. H. Rayner *78*
Thompson-Ryan Dynamo 540
25,000-Volt Dynamo. B. Böhm-Raffay 69
Undulatory Currents. R. Salvadori 887
Unipolar Coreless Dynamo. O. Grotrian 886

Economisers, Feed-Water Heaters and Superheaters.
Economisers. H. F. Schmidt 388
Superheaters, Flue-fired. H. Cruse *38*

Electricity and Traction Works (Descriptive).
Aberdeen New Electricity Works 1039
Albuquerque Gas, Electric Light and Power Company. J. H. Rusby 1040
Aldershot Camps, Electric Lighting of 1041
Antwerp Steel Works, Power Plant in..... 312
Athens and the Piræus, Electricity Supply in 911
Auckland Electric Tramways 797
Aude, France, Power Transmission in the Department of 200
Baltimore, Md., Street Railway Power-house..... 107
Barnstaple Electricity Works 645
Berlin Electricity Works. L. Datterer 560
Berlin Tramways *943*
Birkdale Electricity Works 204
Blaenau-Festiniog, Electric Plant at 203
Bogota Electric Light and Power Plant. F. C. Perkins 105
Boleo Copper Mines, Mexico, Electricity Works of. E. Hoffmann... 310
Bolton, Tramway System of 564
Boston, The Edison Company's Station. I. E. Moultrop and R. E. Curtis 95
Bournemouth Corporation Electric Tramways 649
Brussels Conduit Tramways *946*
„ , New Electric Plant at. A. della Riccia 497
„ St. Gilles Electric Power Station. F. C. Perkins 914
Burlington, Vermont, Water Power at. A. D. Adams *723*
Butte County, California, Electric Power Station in..... 795
California and Virginia Mining Co., Nevada, Electrical Equipment of the Consolidated. L. M. Hall 215
Cardiff Electric Tramways..... 648
Cascade Water-power and Light Company's Power Transmission ... 374
Cauveri Falls Power Transmission 97
Champ Electric Generating Station. Lépine 302

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Electricity and Traction Works (Descriptive), *continued.*

Chatham and District Tramways 110
Chicago Edison Company, Sub-Station of 426
„ Railway Clearing Yards, Electrical Equipment of..... 112
Cincinnati, Georgetown and Portsmouth Electric Railway. E. M. Stevens 915
Cleckheaton Electricity Works..... 427
Colorado Springs Electric Tramways. J. H. Rusby 922
„ „ Power Plant. J. H. Rusby 794
Columbia Electric Tramways 708
Columbus (Ohio) Electric Railway. O. M. Carter 501
Concord, N. H. Water-power Plant 98
Cotton Mill, Electrically-driven. J. A. Montpellier..... 653
„ Mills, Manchester, N. H., Electric Power at 702
Cuantillar Power Transmission, Mexico *140*
Dalles Power Transmission 796
Detroit United Railway Power Stations. T. Farmer 211
„ Rapid Railway System. F. W. Brooks, with W. O. Wood and A. C. Marshall 209
„ United Railway, Track Department of 212
„ , Ypsilanti, Ann Arbor, and Jackson Railway. F. E. Merrill... 210
Doncaster Tramways *591*
Dublin Electric Tramways..... 109
Dunedin Electric Tramways 370
Düsseldorf Exhibition, Electric Power at 496
Eastbourne Electricity Works 792
Elberfeld Suspension Railway *806*
Elizabethport Shops of the Central Railroad of New Jersey, Power Plant at *440*
Evenstad Falls, Power Transmission from, to Arendal and Grimstad 373
Flax Mills, Lowson, Arbroath, Electrical Equipment of..... *727*
Fumay, Ardennes, Hydro Electric Installation for a Boot Factory at. C. Dufour 101
Fure et Morge," Electric Installation of the "Société Hydro-Électrique de 428
Galveston City Railway Co., Power House Equipment 558
Goldstream-Victoria Transmission Plant, Canada..... 208
Great Northern and City Railway 206
„ Orme Tramways 503
Hallau Electricity Works. F. C. Perkins *941*
Hamburg-Blankenese Electric Tramway 213
Hamilton Electric Light and Power Plant. A. D. Adams 104
Hampton Court Electric Tramways..... 921
Hastings Electricity Works *592*
Heating and Lighting Plant, Large Electric 500
Howard's Works, Bedford, Electric Driving at..... 217
Huddersfield Electric Tramways 920
Ilford Electric Tramways *945*
Jungfrau Railway. A. Sidler..... 916
Kalgoorlie Electric Power Scheme 205
Kendal Electric Lighting 201
Korea, Electric Light and Power in. R. A. McLellan 367
Lagos Central Station. C. Hohl 375
Lake Copais Power System 1037
Lancaster Electric Tramways 650
Lausanne, Direct-Current Power Transmission at. Wyssling *726*
Leeds Lighting and Power Station 307
Lighthouse Plant at Heligoland, New Electric. O. Krell, Jr. 1055
Limmat Valley Street Railway. C. S. R. Preller 707
Linwood Paper Mills, Electrical Power at..... 100
Liverpool Overhead Railway..... 214
London County Council Tramways *729*

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Electricity and Traction Works (Descriptive), *continued.*

Louisville, Ky., Slow Speed Generating Units at *441*
Ludwigshafen on the Rhine, Electricity Works at. R. Gassner 199
Manchester and Liverpool Mono-rail Railway *588*
„ (Bloom Street) Electricity Works 646
„ Corporation Electricity Works Extension 301
„ , N.H., Electrical Distribution at 647
Maidenhead Electricity Supply Works 498
Marseilles Electric Tramways. H. Dubs 306
Marylebone, Grove Road, Central Electric Supply Company's Works at..... 644
Mersey Tunnel Electric Railway 918
Metallurgical Works, Hoboken (Belgium), Electrical Installation at. Van der Wallen..... 652
Metuchen, N.J., District Supply Station at 102
Midland Electric Power Distribution 369
Milan-Gallarate-Porto Ceresio Electric Railway. de Marchena and Boucherot ; Korda*..... 917
Newcastle and District Electric Lighting Company's Power Stations. W. D. Hunter 424
Newcastle-upon-Tyne, Electric Power Station at Neptune Bank. W. B. Woodhouse 425
Newfoundland, Hydro-Electric Power Plant in. E. E. Boardway... 910
New Jersey, U.S.A., River Station of the United Electric Light Company of..... 368
New Orleans and Carollton Railroad 108
Newport, R.I., New Power-stations at..... 704
New York and Queen's Electric Light and Power Company's Plant 103
„ Shipbuilding Company's Electric Plant. J. B. O'Hara... 304
„ U.S.A., Rapid Transit Power House 563
Niagara Falls Plant, Compounding Generators, and *319*
North California, Electric Power Transmission in 705
Nottingham Tramways *730*
Otonabee River, Canada, Power Transmission at..... 499
Ottawa Electric Lighting Scheme. A. A. Dion 96
Paris, Electric Railway in. C. L. Durand..... 1047
Park Row Building, New York, Power Plant of 311
Pike's Peak Power Transmission. R. M. Jones 99
Piræus, Electricity Supply in Athens and 911
Pittsburg Street Railway System 923
Pittsfield, U.S.A., Power-house of Berkshire Street Railway Co. 431
Portland, Me., Electrical Supply from Water Power at. A. D. Adams..... 559
Portsmouth, U.S.A., Power Transmission Plant at 308
Printing Works, Draeger, Electric Installation at. J. Reyval 1044
Private Installation in Berlin. E. Josse..... 1045
Redlands, Cal., Mill Creek Power Plant. E. Duryee 703
Richmond (U.S.A.) Light and Power Plant. J. B. Nelson..... 1038
Rodez Electric Tramways. H. Somach..... 562
Romanshorn Power Station, Switzerland. F. C. Perkins 106
Rothsay Electric Tramways 314
St. Petersburg, Central Station of the Société Electricité et Hydraulique in. W. Multhauf 372
Sault Ste. Marie Water-power. F. C. Perkins 303
School of Technology, Manchester 376
Shipbuilding Yard, Stettin, Electric Power at the Vulcan. A. Böttcher 924
Slate Quarries, French, Electricity in 1042
Soulanges Canal Electric Plant..... 53
South Lancashire Tramways System 919
Springfield, Massachusetts, Power Transmission at 309
Substation Plant for High-Tension Polyphase Supply. A. Mossay... 495

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Electricity and Traction Works (Descriptive), *continued.*

Sugar Factory, Three-phase Installation in 651
Sunderland Corporation Electricity Works 202
Swan Falls Power Transmission, Idaho. E. J. Koppitz 429
Switzerland, Electric Power Transmission in *722*
„ Water Power in. F. Loppé *724*
Sydney (Australia) Electric Tramways. F. G. Sykes 502
Theatre, Prince Regent, Munich, Electric Installation at. C. Arldt... 1043
30,000-volt Power Transmission in Europe. H. Behn-Eschenburg... *596*
Trafford Park Power Station 793
Tunbridge Wells Electric Light Station 912
Valtelina Railway. Fumero 430
„ „ D. Korda *942*
Vancouver Transmission Plant. W. H. Allen 913
Vouvry Water-power Electric Works. A. Dumas 371
Warrington Electric Tramways 313
Water Turbine Power Plants, Some Recent. A. Steiger 706
West Bromwich Electricity Works and Tramways 305
Western Ohio Railroad. D. W. Pell 561
Westinghouse Works, Power Equipment of 216
Woollen Mills, Maynard, Mass., New Power Plant for the Assabet... *578*
Worcester New Electricity Works 1036
Yarmouth Electric Tramways 111

Electrochemistry (Industrial).

Alloying of Metals as a Factor in Electroplating. L. Kahlenberg... 762
Aluminium as a Reducing and a Heat-producing Agent. H. O. Hofman 264
„ , Application of to the Preparation of Pure Metals. C. Pio *631*
„ Extraction, Hall Process for. H. Becker 996
„ Preparation of. F. Haber *773A*
„ Present Metallurgy of. J. W. Richards *630*
„ Some Laboratory Observations on. C. F. Burgess and C. Hambuechen 857A
Atkins Hypochlorite Cell. E. Walker 399
Atmosphere, Purification of, by Ozone. E. T. Williams 468
Calcium-Carbide Factory at Cordova. E. Bignami 397
Carbon, Melting of. A. Ludwig *372A*
Chlorates, Electrolytic Manufacture of. J. B. C. Kershaw *482*
Chlorine and Alkali, Electrolytic Manufacture of. F. Glaser 686A
Copper-Cadmium Alloys. P. Denso 1483A
„ from Low-Grade Ores, Electrolytic Recovery of. N. S. Keith 40
„ Refineries, Electrolytic, Finance and Design of. A. Philip 41
„ Refining, Electrolytic, Progress in 1902. T. Ulke 867
Deposits, Metal, Physical Character of. C. F. Burgess and C. Hambuechen 763
Dessolle Process of Electroplating with Copper. H. Fontaine 164
Electrochemical Industries. S. Sheldon *187*
Electrodes, Testing Carbon. F. A. J. Fitzgerald *1018*
Furnace, Electric, in Industrial Chemistry. C. B. Jacobs..... *188*
„ Electric, Experimental and Technical: High-Temperature Electro-Chemistry. R. S. Hutton and J. E. Petavel 768
„ Electric, Smelting of Iron Ores and Production of Steel in. M. Ruthenburg 769
Furnaces, Electric. E. R. Taylor *1017*
„ Electric, for the Manufacture of Carbon Bisulpide. W. Hoskins 400
„ Electric, Preliminary Heating of Charge for. A. Minet and A. Neuburger 873
„ Electrical, Efficiency of. J. W. Richards 998
Galvanised Iron, Tests of. C. Richter 869
Galvanising, Electro-. C. F. Burgess and C. Hambuechen 265

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Electrochemistry (Industrial), *continued.*
Gold, Electrolytic Refining of. D. K. Tuttle 623
Glass, Electrical Manufacture of 165
Graphite, Conversion of Amorphous Carbon to. F. J. FitzGerald ... *481*
Harmet Process for the Electrothermic Production of Steel. J. Reyval 398
High Temperatures, Calorimetric Measurement of. R. Ferrini 319A
Iron Ores, Electric Smelting of. 625
Lead, Electrical Reduction of. P. G. Salom.....1118A
Metal, Electrical Separation of, from Gangue. D. Negreano 1044A
Metals, Electrodeposited, Physical Characteristics of. W. Mc.A. Johnson 868
Metals, Mixed, Electrolytic Separation of. T. Ulke 994
Nickel and Copper, Electrolytic Separation of, from an Alloy obtained from Magnetic Pyretic Ores. E. Günther..... 866
„ Refining, Electrolytic. T. Ulke..... 865
Nitrogen, Fixation of Atmospheric 167
Peroxides of Lead, Nickel and Bismuth, Existence of Electrolytic. A. Hollard 1119A
Pumps and other Auxiliary Apparatus for Electrolytic Installations. D. H. Browne *1015*
Sewage Works, Electrolytic Purification Trials at Salford. J. Corbett 467
Siloxicon, a new Electric Furnace Product. O. E. Dunlap 871
Soldering, Autogenous, by the Oxyhydrogen Blowpipe, Industrial Electrolysis of Water and. F. Jottrand 767
Steel Manufacture, Kjellin's Electric Furnace for. H. Becker..... 997
„ Production in the Electric Furnace. H. Goldschmidt..... 870
„ Production, Keller Electric Furnace and Process for. C. Bertolus 624
Transformers for Electrochemical Work. J. S. Peck *364*
Water-electrolyser of the Cologne Accumulator Works, System Schoop. G. Hagen 754
„ , Electrical Process for Purifying..... 766
„ Purification of by Ozone, at Wiesbaden and Paderborn. G. Erlwein 765
Waterworks, Ozone, at Wiesbaden and Paderborn..... *776*
Zinc Blende, Magnetic Separation of, at Denver, Colorado..... 166
„ Ores, Electrolytic Reduction of. S. S. Sadtler 995
„ Ores and Zinciferous Products, Treatment of refractory. Borchers 469

Equipment of Factories and Mines.
Boot Factory at Fumay Ardennes, Hydro Electric Installation for. C. Dufour 101
Cement-making Plant, Electric. *186*
„ Works, Electric Driving in. 473
Cotton Mill, Electrically-driven. J. A. Montpellier 653
„ Mills, Manchester, N. H., Electric Power at 702
Cranes, Hoists and Lifts, *see* Machine Tools and Appliances.
Flax Mills, Lowson, Arbroath, Electrical Equipment of *727*
Iron and Steel Industries, Electric Power in. D. Selby-Bigge..... 178
„ „ Works, Electric Power in. A. Abraham 177
„ „ „ Electricity in. F. Kylberg 176
Metallurgical Works, Hoboken (Belgium), Electrical Installation at. van der Wallen 652
Mine-draining Plant, Electric, at the Dusseldorf Exhibition 183
Mine Haulage, Electric Locomotives for. G. Gibbs *276*
Mines, Electric Drainage of. J. Goffin, M. Kersten* 181
„ „ Installations for Drainage of. J. A. Montpellier..... 179
„ Ilgner-Siemens and Halske Winding-gear for..... 477
„ Mechanical Appliances in (Coal-cutting and drilling). R. H. Wainford 407
Mines of Kaiserstuhl and Firminy, Notes on the Drainage Installation at. W. Kummer *275*

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Equipment of Factories and Mines, *continued.*

Mining, Quartz, Economy of Electric Power in. C. O. Poole 355
Motors, Individual, Machine shop Driving by. R. T. E. Lozier ... 472
Navy Yards, American, Electric Power in. W. S. Aldrich *728*
New York Ship-building Company's Electric Plant. J. B. O'Hara ... 304
Paper Mills, Linwood, Electrical Power at. 100
Printing Works, Draeger, Electric Installation at. J. Reyval 1044
Pumping, Electric, from a 1,300-foot Level. D. H. Fry 180
Pumps, *see* Machine Tools and Appliances.
Railroad Repair Shops, Power for. R. W. Stovel 46
Shipbuilding Yard, Stettin, Electric Power at the Vulcan. A. Böttcher 924
Shops, Electrically-driven Machine. L. R. Pomeroy 531
Small Isolated Factory Lighting Plants, Economy of. F. O. Runyon 1046
Steel Works, Antwerp, Power Plant in. *312*
Storage Battery as a Factor in Speed Control. H. B. Coho *480*
Sugar Factory, Three-phase Installation in. 651
Sugar Refinery, Electric Motors in. E. J. Brunswick..... 925
Winding Engine, Electrically-driven. 48
„ Engines, Electrically-driven. 49
„ from Great Depths. C. Frericlis 182
„ Machinery, Electric. C. Köttgen 47
„ „ Electrical. C. Köttgen 267
Woollen Mills, Maynard, Mass., New Power Plant for the Assabet... *578*

Gas Engines, Gas Producers, &c.

Alternators, Parallel Working of Gas Engine-driven. E. Rosenberg 1023
Blast-Furnace Gas Engines and Steam Engines. 962
„ Gas in Gas Engines, Use of. C. A. Cochrane..... 456
„ Gases, Motive Power from. B. Donkin *849*
Burger Gas and Gasoline Engine 960
Butler Three-Cylinder Compound Gas Engine 828
Design of Gas Engines. J. Dunlop *259*
Development, Commercial, of the Gas Engine. *260*
Dunlop Gas Engine..... 959
Experiments with Internal Combustion Engines. E. Schimanek ... 748
Fencing of Gas Engines. H. D. Marshall 464
Friction in Gas Engines. H. E. Thompson 958
Internal Combustion Engines. W. H. Booth 827
Iron and Steel Works, Electricity in. F. Kylberg 176
Körting Gas Engine and Blowing Cylinder, 500-h.p. 672
Large Gas Engines, Recent Progress in. H. A. Humphrey *848*
Powers, Different Comparison of Gas Engines of. M. Ringelmann 10
Producers, Gas, and Engines. R. W. A. Brewer..... 961
Test, Gas-Engine. R. Mathot 673
1,000-h.p. Gas Engine..... 761

Insulation and Insulators.

Gutta-percha. W. Ramsay, Miss H. Chick and F. Collingridge 674A
High Electrical Resistances. O. N. Rood *349A*
„ Tension Transmission Lines, Insulators on. C. C. Chesney ... 1031
Insulator Pin, Specifications for Proposed Standard. R. D. Mershon 1030
Lines, Insulated, in India. K. A. Scott-Moncrieff 45
Mica, Effect of High Potential on. J. Härdén 1007
Multiple-Wire Systems, Measurement of Insulation Faults in. E. Müllendorff 908
Networks, Measurement of Insulation resistance of, during Working. T. Bruger 423
Sparking Distances in Air and Oils. E. Jona 249A
Insulators, Testing of. F. O. Blackwell..... 878

Lamps (Arc) and Arc Lighting.

Arc, Electric. Mrs. H. Ayrton. 1046A
Arc Lamps. W. Wedding..... 380
„ , Magnet and Alternate-current. C. H. Bedell 327A

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Lamps (Arc) and Arc Lighting, *continued.*

Arc Spectrum with Heavy Currents. W. B. Huff 91A
Arcs, Electric, Back-E.M.F. in. W. Mitkiewicz 89A
„ High-Voltage. B. Monasch 649A
Currents, Intermittent, for Electric Lighting. S. H. Holden 716
Duddell Circuits. A. Banti 1047A
Economy in Electric Lighting. K. Zipernowsky 936
Flame Arc Lamps. J. Zeidler 804
Illumination. D. Burnett *595*
Lighthouse Plant at Heligoland, New Electric. O. Krell, Jr. 1055
Matzleinsdorf, Goods Station, Austria, Lighting of. C. Jordan 317
Mercury Arc. C. P. Steinmetz 1225A
„ Lamp, Arons, Radiant Efficiency of. W. C. Geer 381
New York, Street Lighting in, and the Proposed Municipal Plant 909
Photometrical Measurements, Commercial Accuracy of. C. H. Sharp 791A
Photometry, Arc Light. A. Blondel and J. Rey 225
Photometry of Electric Lamps. J. A. Fleming, A. Vernon Harcourt,* R. T. Glazebrook,* W. de W. Abney,* J. E. Petavel* 718
Projector, Schuckert. A. Bainville *239*
Standard Lamps for Photometric Purposes. F. v. Hefner-Alteneck 999A
Standard Light, New. J. E. Petavel 935
Westminster, Arc Lighting in *947*

Lamps (Incandescent), and Lighting by Incandescent Lamps.

Calcium Lamp, Edison's Tungstate of. W. J. Hammer *240*
Currents, Intermittent, for Electric Lighting. S. H. Holden 716
Economy in Electric Lighting. K. Zipernowsky 936
Edison Phenomenon. M. Allegretti 467A
Illumination. D. Burnett *595*
Nernst Lamp. A. J. Wurts,* E. F. Phillips.* 226
„ „ O. Bussmann 1054
New York, Street Lighting in, and the Proposed Municipal Plant ... 909
Osmium Lamp. G. Gillon 575
Photometrical Measurements, Commercial Accuracy of. C. H. Sharp 791A
Photometry of Electric Lamps. J. A. Fleming, A. Vernon Harcourt,* R. T. Glazebrook,* W. de W. Abney,* J. E. Petavel* 718
„ of Incandescent Lamps. J. T. Marshall 717
Standard Lamps for Photometric Purposes. F. v. Hefner-Alterneck 999A
Standard Light, New. J. E. Petavel 935
Train Lighting. Strymeersch 222
„ „ by Electricity. A. J. Farnsworth 937
„ „ „ „ C. Jacquin 938
„ „ „ „ W. L. Bliss 939
„ „ „ „ E. A. Sperry *948*
„ „ , Loppé's System of Compounding Dynamos for P. Letheule 489
Train-lighting System, Felt. 1057
„ „ Systems *949*
Trains, Electric Lighting of 382
„ „ „ „ C. Jacquin 574
„ „ „ „ G. D. Shephardson 940
„ „ „ „ J. F. McElroy 1056

Machine Tools, Cranes and Elevators, &c.

Bridge, Bascule, Electrically Operated 268
Capstans, Electric, at the Port of Antwerp. L. Brunhes 629
Centrifugal Machines, Electrically-driven 475
Crane Brakes. E. Rosenberg 54
„ , Electric 476, 773
Cranes, Electric, at Emden Harbour. H. Langner *484*
Cranes at the Harbour on the Rhine, Karlsruhe. F. Winawer and C. Bender *485*
Drill, Portable Electric *883*

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Machine Tools, Cranes and Elevators, &c., *continued.*

Drills, Electric Rock-boring. E. Heubach 61
Elevators, Electric, Power Consumption of. G. F. Sever 51
" " " " " C. Steinmetz,* A. V. Abbott* 175
" Electric Service, at the Paris Post Office. V. Belugon ... 52
Hammer, Electrically-driven 55
Hoist, Electrically-operated Coal. P. O. Keilholtz 479
Lifting Machinery and Conveyers, Electrical. Kammerer 405
Motors for Machine Tools, Continuous-current. F. O. Blackwell ... 544
Power Required to Drive Machine Tools 774
Pumping, Electric, in Great Britain. I. W. Chubb 278
Pumping Plant for Condensing Water. C. Hopkinson 406
Pump, Mine-drawing 184
Pumps at Horcajo, Electrically-driven 50
Steering Gear, Pfatischer's Electric 409
" " Siemens' " 543
Turntables, Electrically-operated 474

Materials of Construction, their Properties and Treatment.

Brittle Bodies, Elasticity of. M. Grübler 696A
Concrete, Strength of. Considère 280A
Metallography, *see* Separate Section .....
Metals, *see* Section Metallography .....

Measurements and Use of Instruments.

Accumulator Tests. M. U. Schoop 863
Accumulators, Output of Lead. A. L. Marsh 761
Air-gaps of Induction Motors. M. Breslauer 690
Ammonium Chloride for Batteries, Rapid Determination of Purity of. G. Rosset 1291A
Angular Velocity and Angular Displacement, Measurement of Variations in. F. Klönne, Franke* 327
Arc Lamps, Flame. J. Zeidler 804
Boiler, Solignac. W. H. Booth 250
" Stirling Marine 5
Boiler Tests, Naval. J. Halligan 822
" with three Internal Flues, Trials of a Steam. L. Lewicki 742
Boilers, Water-Tube 251
Brake Tests. P. Jobst 171
Brakes, Tramway. Poetz, Thonet,* G. Koehler,* von Leiber,* 130
" for Tramcars. C. J. Spencer 128
Cable Testing, Submarine. T. Wolcott 349
Cables, Standardisation of 791
Calorific Power of Coal. Goutal 252
Cars, Reliability of 100 miles Tests of 457
Condenser and Cooler, Combined Surface 528
Conductivity of Boiler Scale, &c. W. E. Ernst 743
Draught Gears, Tests of Spring and Friction 136
Dynamos, Methods of Testing the Efficiency of. E. Pierard 640
" Testing Steam. E. H. Rayner 78
Economisers. H. F. Schmidt 388
Ejecto-condenser. A. Rateau 758
Electrodes, Testing Carbon. F. A. J. Fitzgerald 1018
Electrolysis by Earth Returns, Prevention of. A. Larsen 435
Elevators, Electric, Power Consumption of. G. F. Sever 51
Engine, Gas, Test. R. Mathot 673
" Hult, Rotary Steam, Tests of 324
" Steam, Tests 666
" Test of, with Superheated Steam. J. A. Ewing 604
" Triple-Expansion 601
Engines, Internal Combustion, Experiments with. E. Schimanek ... 748
Friction in the Bearings of High-speed Machines. O. Lasche 816
Fuel Value of North Dakota Lignites. F. A. Wilder 669

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Measurements and Use of Instruments, *continued.*

Furnaces, Efficiency of Boiler. C. E. Stromeyer 607
Gearing, Worm. N. Westberg 174
Generating Sets, Double-Current. F. Collischonn 890
Hohenstein Water-tube Boiler 450
Indicator Springs, Testing. H. F. Wiebe and R. Schwirkus 746
„ „ „ E. Förster 826
Insulation Faults in Multiple-Wire Systems, Measurement of. E. Müllendorff 908
Iron Testing. G. Brion *1019*
Iron, „ of. B. Soschinski 1006
Lamp, Arons Mercury, Radiant Efficiency of. W. C. Geer 381
Lighting, Electric, Economy in. K. Zipernowsky 936
Meters, Energy (Aron System), Methods of Testing. M. Aliamet ... 535
Meters for Unbalanced Three-phase Circuits. R. Arnò 683
Motor Trials, High-speed 151
Motors, Induction, Testing. Larmoyer 783
„ Variable Speed Three-phase. H. Behn-Eschenberg 362
Non-conducting Compositions, Efficiency of. T. H. Beare 389
„ Coverings, Efficiency of. S. H. Davis, J. W. Cobb* 819
Pelton Wheel, Experiments with. W. C. Houston 872
Potential Difference, Measurement of, by Means of the Telephone. F. Fischer 1236A
Power-factor, Measurement of, in Balanced Three-phase System. B. Frankenfeld 92
Power Measurement in Three-phase Systems. C. Mann 1002
„ , Measurement of Electrical. J. Görner 1001
Power Required to drive Machine Tools 774
Powers, Different, Comparison of Gas Engines of. M. Ringelmann 10
Rail Sections, Standardisation of Tramway. W. Howard-Smith 926
Rails, Methods of Testing. C. Frémont 928
Resistance, Electrical, of Bearings. A. E. Kennelly and C. A. Adams 686
Smoke, Prevention of. J. S. Raworth 392
Steam-Pipe Covering. H. G. Stott 391
„ „ Coverings, Tests of. G. H. Barrus 7
Steam, Highly Superheated. Ewing 667
„ , Superheated. E. Foster 527
Steam Turbine, Tests of a De Laval. Dean and Main 605
„ „ „ of at Hartford, Conn. W. L. Robb 145
„ Turbines with Highly Superheated Steam. E. Lewicki 817
Stokers, Mechanical, Tests of. G. A. Hutchinson 824
Stoking and Hand Firing, Comparative Economy of. J. Geldard ... *759*
Strength of Curved Stayed Surfaces. C. G. Robbins *757*
Superheating in Central Station Engines. A. Vanderstegen, Léon Gerard,* Datterer,* Malengraux,* W. Kummer,* 818
Supply Meters, Testing, on Consumers' Premises. W. J. Mowbray 770
Switches and Fuses, Testing Alternate Current. G. W. Howe 1005
„ Sparking in. A. Russell and C. Paterson 57
Transformer Stampings, Best Thickness of. H. Kamps 693
Torsional Stress in the Connection between a Ship's Engines and the Propeller. H. Frahm 2
Train Resistance. J. A. F. Aspinall, A. Mallock,* H. Bell,* F. Bramwell,* S. A. Timmis,* P. V. McMahon,* C. Chree,* F. W. Webb,* D. Halpin,* C. A. Carus-Wilson,* R. H. Smith* 114
Tramway Motors, Testing and Characteristic Properties of. M. B. Field, H. A. Mavor,* A. Jamieson,* W. McWhirter* 126
Turbine, New American. Pfarr 44

Metallography and Treatment of Metals.

Alloys, Effect of Superheated Steam upon the Tensile Strength of. J. L. Hall 1265A
„ Metallic Conduction and the Constitution of. J. A Mathews 771A
„ , of Copper and Manganese. E. A. Lewis 146A

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Metallography and Treatment of Metals, *continued.*

Alloys, Segregatory and Migratory Habit of Solids in, and in Steel below the Critical Points. J. E. Stead 1480A
Aluminium, Alloys of. L. Guillet 584A
Aluminium as a Reducing Agent in Metallurgy. G. P. Scholl..... 949A
„ Near the Fusing-point. A. Granger 1024A
Axle Steel, Microstructure of. H. Fay, A. W. Higgins, and F. W. Coburn 929
Bessemer Process, theory of. F. Fischer 152A
Copper, Researches on Steel and. E. Heyn 1087A
Elasticity of the Elements, Influence of Temperature on. C. Schaefer 810A
Elastic Limit of Metals, Measurement of. C. Fremont 190A
„ Properties of Metals, Effect of Sudden Cooling on. J. Muir 438A
Electroplating, Alloying of Metals as a Factor in. L. Kahlenburg 762
Expansion of Iron, Copper, Aluminium, Brass and Bronze at High Temperatures. W. Dittenberger 639A
Iron and Copper, "Sickening" (loss of strength) of. E. Heyn ... 769A
„ and Steel, Structure of Defective. S. A. Houghton *1021*
Iron, Elasticity and Hardness of Different Kinds of. C. Bach 618A
„ Cast, Unusual Crystals of. J. E. Johnson, Jun., H. M. Howe... 1091A
Iron Castings, Strength of White-, as Influenced by Heat-treatment A. E. Outerbridge 1011
„ , Cementation of. G. Charpy 1010
„ Fe_3C, Probable Existence of a New Carbide of. E. D.... Campbell and M. B. Kennedy 498A
„ Magnetic Properties of Alloys of. W. F. Barrett, W. Brown, and R. A. Hadfield 335A
„ Sulphide of. H. le Chatelier and M. Ziegler 1093A
Lead, Effects of Strain on the Crystalline Structure of. J. C. W. Humfrey 1098A
Load-strain Recorder, Autographic, for Test Specimens. Goodman 695A
Low Temperatures, Elasticity of Copper and Steel at. J. R. Benton 1135A
Magnets, Permanent, Effect of Temperature on. H. B. Loomis... 1248A
„ Temperature Coefficients of. B. O. Peirce 1250A
Metals and Binary Alloys, Structure of. W. Campbell *762A*
Muntz Metal, Annealing of. E. A. Lewis *1039A*
Nickel Steel, Micrographic and Mechanical Study of. L. Guillet... 1013
„ Micrography of. L. Guillet 1092A
„ Changes in. C. E. Guillaume 1134A
„ Dilatation of. C. E. Guillaume 1200A
„ Elasticity of. C. E. Guillaume 1133A
Non-expansive Alloys. C. E. Guillaume 1386A
Photo-microscopy of Metals, Technical. M. A. Richards 896A
Platinum Metals, Volatilisation and Recrystallisation of. L. Holborn and F. Henning 76A
Platinum, Microscopic Effect of Stress on. T. Andrews and C. R. Andrews 192A
„ , Recrystallisation of. W. Rosenhain 154A
Problems, Electro-metallurgical. A. A. Beadle 347
Rails, Track and Collector, Notes on the Resistivity of, as affected by the Chemical Composition. S. Woodfield *238*
Slags and other Metallurgical Products, Sulphur Contents of. J. v. Jornsdorff 137A
Steel, Constitution of. L. Guillet *1020*
„ Drawn, Experimental Researches on. J. R. Ashworth 1268A
„ Influence of the Rate of Cooling on the Structure of. A. Sauveur and H. C. Boynton 1012
„ Microstructure of Hardened. J. O. Arnold and A. M'William 136A
„ Overheated, Effect of Reheating on. K. F. Goransson, H. M. Howe 1090A
„ Overheating Mild. E. Heyn 1089A
Steel Rails, Structure of 714

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Metallography and Treatment of Metals, *continued.*

Steel Rails, Structure and Finishing Temperature of. A. Sauveur 135
„ , Simultaneous Presence of Ferrite and Cementite in. E. F. Lange 1267A
„ Spontaneous Decarburisation of. G. Belloc 1481A
„ Tempered, Dilatation of. G. Charpy and L. Grenet 1197A
„ Theory of the Tempering of. A. le Chatelier 1482A
Steel Tyres, Wear of in Germany. 437
„ Used in Electric Machines. C. Charpy *843A*
Stress, Mean, Throw-Testing Machine for Reversals of. O. Reynolds and J. H. Smith 1302A
„ Repetition of. F. Forster 866A

Miscellaneous (Electric Distribution, Traction and Lighting).

Conduits, Testing Cement. M. Gary *524*
Fruit, Carriage of, by Electric Railway 438
Heating, Hot Water, from a Central Station. E. H. McKnight *658*
Lightning, Protection of Electric Transmission Lines against. Dussaugey 198
Legislative Restraints on Electrical Enterprise, Report of a Deputation from the Institute of Electrical Engineers to the President of the Board of Trade on the subject of *139*
Rules, German, for Electrical Plants 904
Standards, Electrical, and Rules for Installations *516*
Standards of the American Street Railway Association, Report of Committee on 432
Water Power, *see* separate section.

Miscellaneous (General Electrical Engineering).

Accidents and Death due to Industrial Electrical Currents, Nature of. F. Battelli 1258A
Aluminothermy. H. Goldschmidt *1299A*
American Institute of Electrical Engineers, Proposed Developments of. C. F. Scott *281*
Atmosphere of the Central London Railway, Examination of. F. Clowes 1008
B-H. Curve, Empirical Formula for. I. Döry 1004
Bell System, Electric, in the Navy 478
Canal Electric Plant, Soulanges 53
„ Towage, Electric, in Belgium *60*
Clock, Perret's Electric. D. Perret 684
Clocks, Electric, Morawetz System of. Kareis 534
„ Lowne System of Electric 1009
„ Synchronised Electric, Fischer's Magneta System of. A. Lambot 408
Construction, Naval, Electricity in. L. Gerard *66*
Control, Variable Speed. G. S. Dunn,* S. T. Dodd,* A. Williams,* N. W. Storer,* H. Ward Leonard* 627
„ Variable Speed. O. E. Osthoff,* B. J. Arnold,* E. Gonzenbach,* Cutler* 628
Controller, Automatic, for Steam Locomotives 404
Covent Garden Opera House, Electricity at *274*
Dimensions of Contact Surface and Binding Screws for Electrical Apparatus. R. Hellmund 403
Education of Electrical Engineers *280*
„ of the Electrical Engineer. H. W. Buck *185*
Engineering Courses in the United States, Uniformity in the Electrical. S. Sheldon *62*
Engineering in the Technical High Schools of Charlottenburg (Berlin) and Darmstadt (June, 1901), Teaching of Electrical. D. K. Morris *65*
Engineers, The Training of. C. P. Steinmetz *54*

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos

Miscellaneous (General Electrical Engineering), *continued.*

Fire-Alarm System *356*
Gearing, Worm. N. Westberg 174
Heating, Fan-system of 1210A
„ Electric, at Davos-Platz *279*
Iron Testing. G. Brion *1019*
Iron, „ of. B. Soschinski 1006
Lightning and other High-pressure Discharges. P. H. Thomas 173
„ Arresters, Gola's. G. Gola 172
Limits in Heavy Electrical Engineering. J. Swinburne 772
Metric System. F. A. Halsey *987A*
Metrical System of Weights and Measures. A. Siemens 950A
Military Purposes, Civilian Co-operation in the Development of Electrical Devices for. C. D. Haskins *282*
Miner's Safety Lamps, Lighting, by Electricity. E. Brown 353
Mines, Electrical Submarine. J. S. Sewell *536*
„ Equipment of, *see* Equipment of Factories and Mines.
Peat Fuel, Electrical Manufacture of 42
Power, Measurement of Electrical. J. Görner 1001
Signal Corps, Electricity in. S. Reber 354
Standards, Electrical: Report Brit. Assoc. Committee *490A*
Technical Training. E. B. Raymond *63*
Three-phase Systems, Power Measurement in. C. Mann 1002
Turbines, *see* Water-Power Plant
Type-forming and Justifying Apparatus, Méray-Rozar Electric. J. Reyval 410
U. S. Navy, Electricity in. H. George 270
„ „ „ „ W. M. McFarland *357*
„ „ Standard Voltage in. W. V. N. Powelson 269
Water-Wheels, *see* section Water-Power

Miscellaneous (Generators, Motors, and Transformers).

Alternating Current Problems, Graphical Treatment of. E. Orlich 1066A
Armature Reaction, Predetermination of. R. V. Picou *79*
B-H Curve, Empirical Formula for. J. Döry 1004
Bearings, Electrical Resistance of. A. E. Kennelly and C. A. Adams 686
Brake Tests. P. Jobst 171
Design of Electrical Machinery. H. M. Hobart *786*
„ , Recent Electrical. W. B. Esson *881*
Fire Risks from Station Transformers. G. P. Low 77
Harmonics of an E.M.F. Wave, Graphical Calculation of. F. Loppé 105A
Heating of Electric Machines. W. Schüppel *787*
Hysteresis Loss in Iron, Effect of Temperature on. R. L. Wills ... 1070A
Leakage, Magnetic, in Alternate-Current Apparatus. A. Pugliese ... *841A*
Novelties in Electrical Machinery. J. Löwy *696*
Self-inductance. F. Emde *899*
Standardising Electrical Machinery 68
Standardisation of Electrical Machinery 359
Steinmetz's Formula, Theoretical Deduction of, and the Relation Connecting B. and H. J. Döry 1074
Windings, Multiple Wave, Equipotential Connectors for. E. J. Brunswick *294*

Miscellaneous (Steam Plant, Gas Engines, &c.).

Ball Bearings. M. J. Golden 979
Bearings for High Speeds. F. Drouin *988*
„ of High-Speed Machines, Friction in. O. Lasche 816
„ , Plain and Roller. R. Stribeck 745
Belts made from Various Parts of the Hide, Elasticity of. C. Bach *852*
Breakdown, Engine, through Fatigue of Materials 325
CO_2 Recorder, "Ados" 254
Coal, Burning Pulverised, Power System of 452

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Miscellaneous (Steam Plant, Gas Engines, &c.), *continued.*

Coal, Calorific Power of. Goutal 252
Coal Storage Plant. F. M. Bowman 8
Destructors, Refuse. W. F. Goodrich 255
Explosions, Gas, in a Closed Vessel. L. Bairstow and E. C. Horsley 1022A
Feed Waters and their Action on Boilers. C. A. Bowen *262*
Firing Locomotive Boilers, Application of Mazout for. H. Guérin 32
Four-Cylinder Chain, Construction of the Normal and Circle of Curvature to the Pole-Curve of. W. Hartmann *854*
Fuel Combustion, Flame Analysis and. W. H. Booth 609
„ „ Liquid. C. E. Lucke 9
„ for Generating Stations, Oil. E. Stanley 333
„ „ Motors, Comparison of Benzine and Alcohol as. W. A. T. Müller 829
Fuel, Liquid. J. W. Warren 150
„ „ H. F. Schmidt *986*
„ „ for Steam Raising. A. L. Williston *987*
„ „ for Steamships. E. L. Orde, W. Boyd,* J. P. Bedson,* G. Cawley,* C. H. Wingfield* 394
„ Oil, in the U.S. Navy 334
„ Peat. A. Dal 823
Fuel Value of Refuse. W. H. Booth 610
Fuels, Bituminous, Smokeless Combustion of. W. H. Booth *261*
„ Briquetting of. R. Schorr 393
Furnace, Smokeless Calorific 387
Furnaces, Garbage, of Trenton 149
Governor, Action of the Engine, in Parallel Running of Alternators. de Marchena 446
Governing of Steam Engines. B. Rülf 328
Governors, Engine, for Parallel Running. G. R. J. Parkinson 447
„ „ Hand Adjustment of. J. H. Dales 329
„ „ Recording Apparatus for Testing. J. C. Riley 390
Gyrostatic Action and Engineering Design. W. R. Kelsey *37*
Heat, Passage of, Through Surfaces. L. Austin 811A
Indicator Diagrams. A. K. Mansfield 146
„ „ , Defective. A. M. Arter *847*
Joint, Expansion. R. E. Curtis *257*
Lignite as a Fuel for Steam Raising 453
Lignites, North Dakota, Fuel Value of. F. A. Wilder 669
Locke Steel Chain *160*
Lubrication, Graphite. A. Mulhoux *162*
Lubricating Oils, Machine for Testing. G. Dettmar, Arnold,* May,* Wilkens,* Haas* 253
Non-Conducting Compositions, Efficiency of. T. H. Beare 389
„ „ Coverings, Efficiency of. S. H. Davies, J. W. Cobb* 819
Otto Cycle, Entropy Analysis of. S. A. Reeve *859*
Petroleum, Crude, of Low Gravity, Impurities in. P. W. Tompkins 670
Piston, Acceleration of. J. N. le Conte *256*
Pressures, Estimation of High 612
Smoke Prevention. W. C. Popplewell *466*
„ , Prevention of. J. S. Raworth 392
Softener, Water, of the Maschinen-Fabrik Grevenbroich 335
Standardisation of Pipe Flanges and Fittings. R. E. Atkinson *465*
Steam-Pipe Covering. H. G. Scott 391
„ Coverings, Tests of. G. H. Barrus 7
Steam Piping, High-Pressure. W. Andrews 451, 613
Stoker, Arthur Automatic 332
Stokers, Mechanical, Tests of. G. A. Hutchinson 824
Stoking and Hand-Firing, Comparative Economy of. J. Geldard ... *759*
„ , Mechanical, Economy of. W. W. Christie *258*
Thermal Properties of Naphthas and Kerosenes, Some. A. H. Gill and H. R. Healey 320A

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Miscellaneous (Steam Plant, Gas Engines, &c.), *continued.*
Variations in Angular Velocity and Angular Displacement, Measurement of. F. Klönne, Franke* 327
Waste-Heat Engines. Behrend *462*

Motors.
Armatures, the Heating of Toothed-Core. F. W. Davies 191
Ball Bearings. M. J. Golden 979
Bearings for High Speeds. F. Drouin *988*
Bearings of High-Speed Machines, Friction in. O. Lasche 816
Commutation, Sparkless. F. Punga 283
Compounded and Compensated Asynchronous Alternating-current Machines. A. Heyland 781
Compounded Motor, Differentially. W. R. Kelsey 491
Control, A Variable Reluctance Method of Motor Speed. G. F. Packard 545
„ Variable Speed. G. S. Dunn,* S. T. Dodd,* A. Williams,* N. W. Storer,* H. Ward Leonard,* 627
„ Variable Speed. O. E. Osthoff,* B. J. Arnold,* E. Gonzenbach,* Cutler.* 628
Construction, American Practice in Electric Motor *900*
Design of Polyphase Machines. D. Bergman 490
Four-speed Three-phase Motor, and Shunt Motor for 350–1,600 Revs. H. Behn-Eschenburg 547
Heating of Traction Motors. E. Kerbaker 635
Heyland Single-Phase Motor 289
Heyland's Asynchronous Motor. Boy de la Tour *82*
„ Induction Motor. Boy de la Tour 782
Induction Motor, Circle Diagram of. J. K. Sumec *789*
„ Motor Calculation. A. Lindström *81*
„ „ Characteristics. A. S. M'Allister 637
„ „ , Losses in a Large. F. Bodensteiner 363
„ Motor Speed Regulation. M. Osnos 548
„ „ , Theory of Single-Phase. H. Görges 895
„ „ , Variable Speed 546
„ Motors, Air-Gaps of. M. Breslauer 690
„ „ Circuit-breaker for. A. Bianchi 636
„ „ Effect of Closed Slots in Stator Cores of. W. Mollier 196
„ „ H. S. Meyer *83*
„ „ Measuring the Slip of. A. Meynier 549
„ „ Phase Compensation for. M. Osnos 493
„ „ Separation of Losses in. O. S. Bragstad, and J. L. la Cour 692
„ „ Tandem Coupling of. M. Breslauer 691
„ „ Testing of. P. Meunier 894
„ „ „ Larmoyer 783
Machine Tools, Continuous-Current Motors for. F. O. Blackwell ... 544
Railway Motors and Electric Railroads *582*
Resistances, Graphical Determination of Starting and Regulating G. J. Erlacher *297*
Rotary Magnetic Fields. Noaillon 784
Rotors, Squirrel-Cage. M. Osnos 285
Series Motors, Single-Phase Alternating-Current. P. Girault 688
Single-phase Motor with Phase Compensation. M. Latour 893
Speed Control of Electric Motors on Constant Pressure Mains. W. B. Sayers, H. A. Mavor,* H. Lea,* W. A. Chamen,* W. L. Spence,* M. M'Lean,* T. B. Murray.* 892
„ of Induction Motors, Regulation of. G. Winter 1027
Starting Continuous-Current Motors. L. Brunhes *788*
„ Single-Phase Motors. A. Schwartz 290
Synchroniser, Rotary 687
Synchronous Motors, Monophase. G. Markovitch 195

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Motors, *continued.*

Synchronous Motor, Wattless Current of. E. Rosenberg 689
Traction Motors, Characteristic Curves of. Barbillion 1025
Tramway Motors, Rating of. M. G. Rasch 125
„ „ Testing and Characteristic Properties of. M. B. Field, H. A. Mavor,* A. Jamieson,* W. McWhirter,* 126
Variable Speed Motor Work, Three-Wire System for. N. W. Storer... 543
„ „ Shunt Motors. F. Müller 1026
„ „ Three-Phase Motors. H. Behn-Eschenburg 362

Oil Engines.

Alcohol Engines Exhibited in Berlin, 1902. R. Schöttler *851*
„ Motor, Chemical Behaviour of Alcohol in. A. Neuburger ... 11
Brooke Engine and Carburetter 617
Burger Gas and Gasoline Engine 960
Carburettor, Automatic, for Explosion Engines. A. Krebs..... *856*
„ Calvert 14
„ Duvinage. A. Mulhoux..... 13
„ Sthénos. J. Caël *346*
Commutator, Napier Ignition..... 336
Diesel Engine, American Type *862*
Double-Acting Internal Combustion Engine 616
Experiments with Internal Combustion Engines. E. Schimanek ... 748
Fuel for Motors, Comparison of Benzine and Alcohol as. W. A. T. Müller 829
Ignition, Electric, Function of Auxiliary Spark-Gaps in. W. Pfitzner 830
Internal Combustion Engines. W. H. Booth 827
Ivel Agricultural Motor 26
Lister Two-Stroke Engine 127
Packard Transmission 156
Power-Limit, Higher, of Benzine Motors for Automobiles. H. Güldner *850*
Trials, High-Speed Motor 151
12 h.p. Spirit Locomobile (portable engine) 674

Power Transmission and Distribution.

Advantages of Electric Transmission. F. J. A. Matthews *228*
Alternating Currents, Power Transmission by. E. Walch..... 1032
Batteries, Regulating, Connections of. H. de Waal 556
Boosters, Use of Negative 553
Central Station Charging Systems and Rates in Use in U.S.A. 299
„ Supply Stations, Motive Power from. R. A. Chattock 1028
Composite Transmission, Bedell System of. A. S. McAllister 697
Continuous-Current Systems, High-tension. A. S. Barnard, J. F. C. Snell,* S. Z. de Ferranti,* C. H. Wordingham*..... 89
Cost of Electric Power Transmission. A. D. Adams *515*
Distribution, Two- *versus* Three-wire. J. F. C. Snell, E. T. Ruthven Murray,* F. A. Newington,* R. A. Chattock,* J. N. Schoolbred,* J. S. Highfield,* V. A. H. McCowen,* W. H. Tittensor,* A. P. Trotter,* H. F. Proctor* 91
Earthing. H. Faraday Proctor, Raphæl,* Highfield,* F. A. Newington,* V. A. H. McCowen,* A. P. Trotter,* S. F. Walker,* W. B. Esson*..... 93
"Earthing," Protection Value of. K. Wilkens 552
Earthing the Middle Conductors. A. J. Abraham, G. Hooghwinkel,* E. Morgan* 94
Electrolysis by Earth Returns. F. L. Johnson *585*
„ „ „ „ at Erie, Pa *586*
Europe, Central Power Stations in. L. Gerard 906
Five-Phase System. E. W. Ehnert 698
Fluctuating Loads in Power Transmission Plants, Equalisation of. G. Meyersberg 1034
High-Pressure, Extra, Transmission Systems. W. Blanck *719*
„ Tension Transmission, Pressure Rises in. W. B. Woodhouse *231*

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Power Transmission and Distribution, *continued.*
High-Tension Work in the Far West. G. H. Lukes *230*
Insulators on High-Tension Transmission Lines. C. C. Chesney ... 1031
Limits, Physical, of Electric Power Transmission. A. D. Adams ... 300
Line, Transmission, Calculation of a 50,000-H.P., 80,000-Volt, 200-Mile. C. W. Hutton and R. Crowell 365
Lines, Electric Transmission. A. D. Adams..... 901
„ Protection of Long-distance Transmission. F. A. C. Perrine 87
„ „ „ „ C. H. Baker, L. Denis, P. N. Nunn, H. J. Gille, and P. M. Lincoln *439*
Load Factor, Improvement of *579*
Modern Tendencies in the Development and Transmission of Power. J. J. Flather 700
Networks, Calculation of Alternate-Current. A. Luraschi..... *720*
„ „ „ Distributing. H. Gallusser *1059*
„ Graphical Treatment of Conducting. G. König *721*
Paris, Electricity Supply in, in 1901. Lauriol *659*
Pole Lines for Power Transmission. A. D. Adams..... 551
Polycyclic System of Distribution. E. Arnold 366
Power, Cost of. M. J. Eichhorn *229*
Power-Factor in Three-Phase Circuits. A. S. McAllister 554
„ „ „ „ „ „ L. L. Perry 555
„ in Unequally-loaded Three-Phase Circuits, Measurement of. R. Arno *577*
Rotary Converter Distribution, New 421
Self-induction and Capacity in Transmission Lines, Effects of. G. H. Baillie 90
Single-phase Transmission Line, Model showing Distribution of E. M. F. and Current along. W. S. Franklin 1035
Station Working, Power, A. L. C. Fell..... 85
Stations, Tramway Power. M. Eisig *580*
Statistics of the Operation of the "Secteur Municipal" in Paris in 1901. Lauriol 643
Steam Railways, Power-Station Arrangement for ElectricallyOperating. C. J. Spencer 907
Substation Equipment and Transmission Line, Influence of, on the Cost of Electricity Supply. A. Stewart 1033
„ Plant for High-Tension Polyphase Supply. A. Mossay 495
Supply Works Costs, Electricity *1060*
Surges in Transmission Circuits, High-Potential. F. O. Blackwell,* H. W. Fisher,* C. P. Steinmetz,* B. A. Behrend* 88
Transformers, Arrangement of, in Alternating-Current Installations. G. W. Mayer 903
Transformers in Transmission Systems. A. D. Adams 902
Three-phase System, Balanced, Measurement of Power-factor in. B. Frankenfield..... 92
Voltage Regulation, Automatic. H. C. Wirt..... 699
„ Regulation of the Vienna Five-Wire Municipal Lighting Plant. R. Hiecke..... 905
Water-power, *see* separate section.
Works, Electricity, Steam *v.* Water Power for. A. Hecker 701

Rectifiers.
Electrolytic Rectifiers. C. F. Burgess and C. Hambuechen..... *1014*
„ „ A. Nodon..... 1238A
„ „ , Aluminium. E. König..... 1445A
Cooper-Hewitt Rectifier 638
Electromagnetic Rectifier. G. H. Morse 480A
Nodon Electric Valve 695

Steam Engines, *see* also Supplementary Index of Works on p. 501
Alternators, Direct-connected, Engine Speeds for. E. Knowlton ... 72
Balancing of Rolling Mill Engines. G. Service *678*
Ball Bearings, Steel 458

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Steam Engines (*see* also Supplementary Index of Works on p. 501), *contd.*
Blast Furnace Gas Engines and Steam Engines 962
Corliss Engines 1
Dynamos, Testing Steam. E. H. Rayner *78*
Engines with several Vapours, Theory of. K. Schreber 813A
Glasgow Tramways Power Station, Engines at *459*
Governor for Steam Engines, Elisha Gray's Electromechanical 747
"Heat-Waste" Engines, "Series-Vapour" and, as Supplementary to Single-Vapour Engines. R. H. Thurston *985*
High-Speed Electrical Generating Plant. T. H. Minshall 956
„ Engine 602, 603
„ „ , Balanced 144
Indicator Diagrams, Defective. A. M. Arter *847*
Marine Screw Engines, Economy of. E. Hall-Brown *676*
Piston, Solid, Solid Rings on 611
Portable Engines, Modern. W. Fletcher *157*
Rotary Steam Engine, Hult, Tests of *324*
Sleeper Steam Engine *326*
Slide Valves, Gridiron *756*
Specific Heats of Air and Steam. W. Makower 1214A
Stations, Large Electric Power, Engines for. A. A. Day *159*
Steam, Saturated, Efflux of. V. Blaess 812A
„ Wet, Adiabatics of. F. Foster *860*
Superheated Steam. E. Foster 527
„ „ , Effect of, upon the Tensile Strength of Alloys. J. L. Hall 1265A
„ Steam, Highly. Ewing 667
„ „ Test of Engine with. J. A. Ewing 604
Superheating in Central Station Engines. A. Vanderstegen, Léon Gerard,* Datterer,* Malengraux,* W. Kummer.* 818
Tandem Steam Engine, 2,000-h.p. *677*
Tests, Steam-Engine 666
Torsional Stress in the Connection between a Ship's Engines and the Propeller. H. Frahm 2
Triple-Expansion Engine 601
Turbine, Steam. E. H. Sniffin *263*, 323
Turbine, Steam, at Hartford *35*
„ „ Applications, Recent. G. L. Parsons *983*
„ „ Tests of, at Hartford, Conn. W. L. Robb 145
„ „ „ De Laval. Dean and Main 605
Turbines, Steam. K. Anderson *460*
„ „ S. E. Fedden *158*
„ „ , and Heat-Engines. A. Stodola 815
„ „ Operation of, with Highly Superheated Steam. G. Lewicki 817
Turbo-Alternators. W. B. Woodhouse *461*
Valve for Compound Engine 526
Waste-Heat Engines. Behrend *462*
Works, Electricity, Steam *v.* Water Power for. A. Hecker 701

Telegraphy (excluding Wireless Telegraphy).
Alternate Currents for Land Telegraphy. E. F. Northrup 597
Batteries, Primary. Tuch 688A
Baudot Multiple Type-printing Telegraph *599*
Cable, Proposed Non-Inductive. C. E. Fritts 241
Cable Relay, Muirhead's. J. Munro 321
„ Ships "Restorer" and "Patrol" 810
„ System of the Philippines, Military. E. Russel 385
„ Testing, Submarine. T. Wolcott 349
Carrier-call System, Louis' Electric 664
Coherer for Submarine Cable Work. E. Guarini *246*
Commutator at Amsterdam, Central Telegraphic 520
Conduits, Testing Cement. M. Gary *524*

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Telegraphy (excluding Wireless Telegraphy), *continued.*
Disturbances on Underground Telegraph Cables. W. Schönau 519
Electrograph, Improved 445
Fire Alarms, Transmission of. E. B. Ellicott 521
Hamburg Telegraph Station. Grallert 444
Hughes' Type-printer, Modified Keyboard for. P. Genuardi *955*
Manipulator for Continuous Currents, Telegraphic. Marchesini..... *1068*
Mercadier's Multiplex Telegraph. J. Anizan 442
Murray Printing Telegraph 951
Posts and Brackets, Telegraph and Telephone. J. A. Montpellier ... 950
Pupin's Asymmetrical-Current Device for Telegraph Circuits 443
Relay, Vibrating Cable-. K. Gulstad 143
Rowland Rapid Telegraph System 384
Submarine Cable for the Mexican Government..... 518
„ Cables, Long, Resistance and Capacity in. J. E. Young. 952
Telephony over Telegraph Lines. F. Nissl 244
Van Rysselberghe Telegraph System 663

Telegraphy (Wireless).
Antennæ in Wireless Telegraphy. Q. Majorana 1065
Braun Wireless Telegraph System. A. F. Collins 242
Cable Work, Submarine, Coherer for. E. Guarini *246*
Coherer, Action of Filings. M. A. Ketterer 1063A
„ Italian Navy 1061A
Coherers. E. Drago 476A
„ and Auto-coherers. O. Rochefort 475A
„ , Steel Needle. J. Fényi.....1062A
Daylight, Effect of, on Wireless Telegraphy. G. Marconi 812
De Forest Wireless Telegraph System..... 386
Direction of Wireless Telegraph Signals, Detection and Determination of 243
Earth-Current Disturbances, Electric, and their Origin. J. E. Taylor 1221A
Experiments in Wireless Telegraphy, Recent. A. Turpain 1061
„ , Wireless Telegraph, on Board the "Carlo Alberto." N. Maskelyne *737*
„ Wireless Telegraph, on Board the "Carlo Alberto." L. Solari *736*
Hertz Resonator. A. Turpain *672A*
Hertzian Wave Telegraphy. J. A. Fleming *1067*
„ Waves in Storms. F. Larroque 472A
Italian Wireless Telegraph Stations. A. Banti *1069*
Lightning, Automatic Registration of. A. Turpain..... 247A
Lodge-Muirhead Wireless Telegraph System. H. C. Marillier 1064
Magnetisation by High-frequency Oscillations. F. Braun.....1252A
Mechanical Illustration of Braun's Wireless Telegraphy. M. Wien ... 658A
Oscillatory Discharge, Resonance Method for Determining the Period of. P. Drude..... *839A*
„ Discharges, Decay of. F. Beaulard 471A
Patents, Recent Wireless Telegraph *738*
Polarised Rays, Circularly or Elliptically, of Electric Force. A. Artom 1232A
Powders, Iron, Magnetic Properties of. C. Maurain 1251A
Receiver, Telephonic, for Wireless Telegraphy. L. Bleekrode 322
Resonance in Wireless Telegraphy. M. Wien.....*1083A*
Selective Wireless Telegraphy. A. Bull..... 1063
Spark-gap with Tesla Coil, High-pressure. F. J. Jervis-Smith 251A
Stationary Electric Waves made Visible. J. J. Borgmann.....1231A
Stations, Portable Wireless, for Military Purposes. A. Wilke 1062
Systems, Analysis of Wireless Telegraph. A. F. Collins *600*
Telephone Receiver, Relay, for Wireless Telegraphy. A. H. Taylor...1064A
United States Navy, Wireless Telegraphy in. A. M. Beecher 735
Vibrations, Demonstrations of Electric. L. Zehnder *745A*

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Telegraphy (Wireless), *continued.*
Wave Detector, Electric. G. M. Minchin 1058A
„ „ Magnetic Electric. G. Marconi *1060A*
Waves, Electric, and Marconi's Telegraphy. G. Seibt *1077A*
„ „ and Resonance, Lecture Illustrations of. G. Seibt... *1082A*
Wireless Telegraphy. E. A. N. Pochin 1066
„ „ over Sea and Earth. H. B. Jackson 811

Telephony.
Anglo-Belgian Telephone Cable. Leduc 813
Arc-light Telephony. E. Ruhmer 454A
Berlin, Telephony in. Dankwardt 245
Disturbances on Telephone Lines. P. M. Lincoln 954
Duddell Circuits. A. Banti 1047A
Düsseldorf Telephones. Kehr *814*
Exchanges, Telephone, Economic Design and Management of. A. V. Abbott *248*
Independent Telephony, Needed Improvements in. L. W. Stanton *247*
Lausanne New Telephone Exchange. Detailed Description of Central Office Apparatus on Branching System. L. Vanoni... *739*
Lightning-Protectors for Telephone Lines. A. Franke, Strecker.*... 598
Lines, Telephone. G. A. Campbell 953
Long-distance Telephone Lines. F. Dolezalek and A. Ebeling 665
Posts and Brackets, Telegraph and Telephone. J. A. Montpellier ... 950
Railways, Electric, Telephones on. Luzzati 715
"Singing" Arcs, Using an Aluminium Condenser to Produce. W. Mitkiewicz 90A
Substation System for Telephone Exchanges, Automatic. J. Baumann 522
Switchboard for Telephone System, Multiple. Dankwardt *740*
„ Specifications, Common Battery. O. L. Goodrum *525*
„ , Telephone, Evolution of. T. D. Lockwood *741*
Telegraph Lines, Telephony over. F. Nissl 244
United Kingdom, Future of the Telephone in. J. E. Kingsbury *249*
Vibrations of a Telephone-membrane. R. Kempf-Hartmann 79A
Wires, Telephone, Variation of Tension of. P. Vandeuren 523

Traction, Electric (Accumulator).
Accumulator Traction. D. Vivita 799
Batteries, Accumulator, in Tramway Work. G. Cristoforis *594*
Braking, Recuperative, of Electric Automobiles. W. A. T. Müller... 568
Locomotives for Goods, Accumulator. T. J. Fay 436
Systems, Electric Traction. W. R. Cooper 116
Systems of Traction. E. A. Ziffer 117

Traction, Electric (excluding Accumulator Traction and Descriptions of Power Stations).
Axle Steel, Microstructure of. H. Fay, A. W. Higgins, and F. W. Coburn 929
Brakes, *see* section Accessories and Appliances (Traction).
Canal, Haulage, Ganz System of. G. Szasz 933
„ Electric Haulage, on the Miami and Erie 180
Canals, Electrical Haulage on. E. W. Marchant *944*
„ Electric Towage on, in Belgium *60*
„ Electric Traction on. L. Gerard 509
Car, Ordinary Street, Electrical Equipment of. A. B. Lambe 133
„ Sheds, Arrangement of. M. A. Trantweiler 132
Circuit-breaker, Automatic for Trolley Wires 377
Collectors for Heavy Traction. G. T. Hanchett *233*
Commercial Management of Electric Tramways. T. W. Sheffield ... *731*
Construction, Overhead, of Detroit United Railway *235*
Control for Trunk Line Service, Multiple Unit, Voltage Speed. H. Ward Leonard 567
„ of Trains, Automatic Electric. G. E. Walsh 803
Central Stations for Traction. C. Thonet 113
Draught Gears, Tests of Spring and Friction 136

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Traction, Electric (excluding Accumulator Traction and Descriptions of Power Stations), *continued.*

Draw-bar Pull Rating of Engines. H. A. Fergusson 660
Drop, Voltage, in Electric Tramway Rails. R. Ulbricht 583
Electrolysis by Earth Returns. A. Larsen..... 511
" " " , Prevention of. A. Larsen 435
Fault Localising on Tramway Systems. A. Johnston. 725
Freight Business on the Chicago, Harvard and Geneva Lake Railway 142
Guard Wires on Electric Tramways..... 662
" " " " " and the New Board of Trade Regulations..... 656
High-Speed Electric Interurban Railways. G. H. Gibson..... 517
Light Railways, Narrow *versus* Ordinary Gauge on. C. de Burlet, L. S. Robinson,* L. Janssen* 118
Lighting Regulation, Electric Railway. H. Schuh 227
Locomotive, 10,000-volt High-speed. W. Reichel 315
" Electric, for Rack Railway..... 256
London County Council's Conduit Tramways 207
Long-Distance Electric Railroading. L. Duncan..... 565
Maintenance of Tramways, notes on the Wear and. C. F. Wike..... 121
Motors, Tramway, Rating of. M. G. Rasch 125
" " Testing and Characteristic Properties of. M. B. Field, H. A. Mavor,* A. Jamieson,* W. McWhirter* 126
Poles, Electric Tramway. G. G. Braid 809
Practice, European Electric Railway. H. Vellguth 141
Practice, European, in Three-phase Traction..... 581
Problems, Traction, Graphical Solution of. P. Pforr 221
" " " Treatment of. R. Mauermann 734
Rail Design, Girder. S. Grant 661
" Joint, Schuler..... 506
" Joints and Bonds, Electrically Welded 587
" Sections, Standardisation of Tramway. W. Howard-Smith 926
" " for Street Railways. B. J. Arnold 798
Railroads, Electricity on. E. Fränkel..... 504
Rails, Method of Testing. C. Frémont 928
" Steel, Structure and Finishing Temperature of. A. Sauveur... 135
" Structure of Steel 714
" Track and Collector, Notes on the Resistivity of, as affected by the Chemical Composition. S. Woodfield 238
Railway Motors and Electric Railroads 582
Railways, Electric. J. Swinburne and W. R. Cooper, W. E. Langdon,* W. M. Mordey,* S. P. Thompson,* C. A. Carus-Wilson,* P. V. McMahon,* W. Geipel,* A. A. Campbell-Swinton,* M. Holroyd-Smith* 115
" Electrical Traction on. W. M. Mordey and B. M. Jenkin, Kelvin,* R. E. B. Crompton,* A. Siemens,* P. Dawson,* A. B. W. Kennedy,* F. W. Webb,* J. Holden,* S. B. Cottrell,* F. Bramwell,* D. Fox,* J. Swinburne,* J. W. Barry,* W. Geipel,* P. V. McMahon,* F. Hudleston,* B. M. Jenkin,* C. E. L. Brown,* E. Huber,* G. Kapp* 710
" Existing, Electric Traction in Relation to. J. W. Jacomb-Hood 316
Resistance, Traction, of Small Mine Cars 1051
" Train. J. A. F. Aspinall, A. Mallock,* H. Bell,* F. Bramwell,* S. A. Timmis,* P. V. McMahon,* C. Chree,* F. W. Webb,* D. Halpin,* C. A. Carus-Wilson,* R. H. Smith*..... 114
Rolling Stock, Employment of. J. H. Neiszen..... 131
" " Tramway. R. H. Simpson 593
Safety Apparatus, Electrical, for Trains in Motion 932
Signalling, *see* section Accessories and Appliances (Traction).
Single-phase Railway, American. B. G. Lamme, C. P. Steinmetz,* B. J. Arnold* 654

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Traction, Electric (excluding Accumulator Traction and Descriptions of Power Stations), *continued.*

Sleet Storms, Third-Rail Traction and 512
Speed Control, A Series-Parallel System of. G. W. Fowler 507
„ , Power and Efficiency Curves. E. J. Burdick *232*
Speed Time Curves. C. O. Mailloux *320*
Speeds, Schedule, on Electric Railways. W. Park 930
Stopping Tramcars and Trains, Cost of. R. W. Western 566
Substations, Converter, Equipment of Railways with. A. D. Adams... *732*
Suburban Railways, Electric. E. A. Evans 120
Surface-Contact System. F. Drouin 119
„ „ „ Lorain. C. E. C. Strawfield 1049
„ „ „ Dolter *234*
„ „ Systems. G. Paul 433
„ „ , Ramossot, Tramway System. A. Bainville 711
Systems, Electric Traction. W. R. Cooper 116
Systems of Traction. E. A. Ziffer 117
Taeggi's Electric Post. W. P. Digby..... 220
Taeggi-Piscicelli Postal System. R. Salvadori 934
Telephones on Electric Railways. Luzzati 715
Telpherage. C. M. Clark 124
Third-Rail Contact. G. T. Hanchett 801
„ „ Traction 931
Track Construction of Suburban and Interurban Electric Railways. S. S. Hoff..... 505
„ Perfect *808*
Track Welding, Electric. W. Fawcett 1050
Tramways, Electric. C. Hopkinson, B. Hopkinson and E. Talbot, R. E. B. Crompton,* A. P. Trotter,* W. E. Ayrton,* C. V. Boys,* H. Davey,* A. B. W. Kennedy,* E. M. Lacy,* R. Appleyard,* P. Dawson* 709
Tramways, Wear and Maintenance of. C. F. Wike..... 219
Transporters, Electric Waggon. A. Taveau 218
Three-phase Traction, European Practice in. C. L. de Muralt..... 122
Trolley for Electric Tramways, Automobile Repair. L. Fournier ... *584*
„ Wire, Figure-of-eight. M. Schiemann 510
„ Wires, Tramway, Safety Devices for. D. S. Munro 802
Truck for Electric Service *807*
Tube Railways in London. P. V. McMahon..... 123
Tyres, Steel, Wear of, in Germany 437
„ Wear of Tramway. A. Spilberg 927
United States, Electric Traction in. G. Gillon..... *733*
Westinghouse Electric Vehicle Equipment..... *237*
Wheels, Cast-iron, under Heavy Cars 134

Traction (Mechanical).

Resistance, Train. J. A. F. Aspinall, A. Mallock,* H. Bell,* F. Bramwell,* S. A. Timmis,* P. V. McMahon,* C. Chree,* F. W. Webb,* D. Halpin,* C. A. Carus-Wilson,* R. H. Smith* 114
Signalling, *see* section Accessories and Appliances (Traction).

Transformers and Rotary Converters.

Commutators and Slip-rings. R. Hellmund 414
Field Distortion and Armature Reaction. R. Bauch 284
Rotary Converter Distribution, New 421
„ Converters, Double-Current Generators and. S. Woodfield 286
„ „ Practical Working of. J. R. Salter 292
„ „ Single-phase. A. Banti 492
Six-phase Transformation. A. S. M'Allister 550
Standardisation of Specifications Relating to Generators and Transformers. G. Dettmar 360
Subdividing Alternating P.D.'s, Apparatus for. C. Heinke 420
Synchronising, Notes on. J. M. Roman..... 76
Transformer, Diagram of General Alternating Current. F. Eichberg *494*

For the **Explanation** of this Index see p. 471.

Digitized by Google

Abstract Nos.

Transformers and Rotary Converters, *continued.*

Transformer, Graphical Method of Predetermining Regulation of Unequally Loaded Three-Phase. A. König 694
Transformer Regulation. G. Grassi 785
„ Stampings, Best Thickness of. H. Kamps 693
„ Switches, Automatic. J. Schmidt 352
Transformers, Arrangement of, in Alternating-Current Installations. G. W. Mayer 903
„ Burnand 291
Transformers for Electrochemical Work. J. S. Peck 364
„ in Transmission Systems. A. D. Adams 902
„ , Station, Fire Risks from. G. P. Low 77
„ Voltage Drop in. M. Breslauer 642

Water-Power Plant, *see* also Supplementary Index of Works on next page.

Exciter Turbine, Governing 874
Flow of Water in Channels of Varying Cross-Section, Some Characteristics of. T. E. Stanton 531A
Pelton Wheel, Experiments with. W. C. Houston 872
Turbine Development in America. A. C. Rice 273
„ , New American. Pfarr 44
„ „ „ C. Herschel, Pfarr* 471
Turbine Practice, Modern, and the Development of Water Powers. W. E. Thurso 470
„ Practice, Modern, and the Development of Water Powers. J. W. Thurso 771
Turbines, High-pressure Water, Nozzles for. W. S. Smith 168
Water-power in Electrical Supply. A. D. Adams 590
Water-power in Ireland. W. Tatlow, W. F. Barrett,* M. Harriss,* J. Perry 86
Water-wheels, Tangential 681
Water Turbine Power Plants, Some Recent. A Steiger 706
Works, Electricity, Steam *v.* Water Power for. A. Hecker 701

For the **Explanation** of this Index see p. 471.

Digitized by Google

SUPPLEMENTARY INDEX OF WORKS AND INSTALLATIONS DESCRIBED IN THIS VOLUME.

CLASSIFIED ACCORDING AS THEY ARE DRIVEN BY (1) STEAM, (2) WATER-POWER, OR (3) GAS-ENGINES.

[*Special Features are denoted by letters in brackets. Thus*:—(B) *signifies Battery;* (S) *Superheater;* (ST) *Steam-turbine.*]

STEAM-DRIVEN.

Aberdeen, 1039 ..... (B)
Albuquerque, 1040
Aldershot Camps, 1041 .....(ST) (B)
Anjou, Slate Quarry in, 1042 ..... (ST)
Antwerp Steel Works, 312
Athens, 911 .....(S) (B)
Auckland, 797
Baltimore, Md., 107
Barnstaple, 645 ..... (S)
Berlin 560, (Oberspree and Moabit), 1045 ..... (S)
Birkdale, 204 ..... (B)
Boleo, Mexico, 310
Bolton, 564
Boston (Edison Co.), 95 ..... (B)
Bournemouth, 649 ..... (S)
Brussels, 497
Brussels (St. Gilles), 914 ..... (B)
Cardiff, 648..... (B)
Chatham, 110
Chicago, 112
Chicago, Randolph St. Substation, 426
Cincinnati, Georgetown, and Portsmouth Railway, 915
Cleckheaton, 427 ..... (B)
Colorado Springs, 794
Colorado Springs Tramways, 922
Columbia, 708
Columbus (Ohio) Electric Railway, 501
Detroit Rapid Railway, 209
Detroit United Railway, 211
Detroit, Ypsilanti, Ann Arbor and Jackson Railway, 210
Doncaster Tramways, 591
Draeger Printing Works, 1044
Dublin, 109
Dunedin, 370
Düsseldorf Exhibition, 496..... (ST)
Eastbourne, 792 ..... (S)
Elberfeld, 806
Elizabethport, 440
Galveston City Railway Co., 558
Great Northern and City Railway, 206
Great Orme, 503
Hallau, 941
Hamburg-Blankenese, 213..... (B)
Hampton Court Tramways, 921
Hastings, 592..... (ST)
Hoboken (Belgium), 652
Howard Works, Bedford, 217
Huddersfield Tramways, 920..... (S)
Ilford Tramways, 945
Kalgoorlie, 205
Kendal, 201 ..... (B)
Korea, 367
Lagos, 375
Lancaster, 650
Leeds (Lighting and Power), 307
Limmat Valley Railway, 707
Linwood, 100
Liverpool Overhead Railway, 214
London County Council, 729
Lowson Flax Mills, Arbroath, 727
Ludwigshafen, 199
Maidenhead, 498 ..... (B)
Manchester, 301
Manchester (Bloom Street), 646..... (S)
Manchester and Liverpool Railway, 588
Manchester School, 376
Marseilles Tramways, 306..... (6-phase)
Marylebone (Grove Rd.), 644..... (B)
Mersey Tunnel Railway, 918..... (B)
Metuchen, N. J., 102
Midland Power, 369
Milan-Gallarate-Porto Ceresio Railway, 917 ..... (B)
Mirecourt (Vosges), 653
Newark, N.J., 308
Newcastle, Neptune Bank, 425 ..... (ST)
Newcastle, 424 ..... (ST)
New Orleans and Carollton, 108
Newport, R. I., 704 ..... (S)
New York and Queen's Co., 103
New York, Rapid Transit Power, 563 (ST)

Digitized by Google

New York Shipbuilding Co., 304
Nottingham, 730
Paris, Electric Railway in, 1047
Park Row Building, N.Y., 311 ..... (B)
Piræus, 911..... (S) (B)
Pittsburg, 923
Pittsfield, U.S.A., 431
Portsmouth, U.S.A., 308
Prince Regent Theatre, Munich, 1043 (B)
Richmond (U.S.A.), 1038
Rodez, 562 ..... (S)
Rothsay, 314 ..... (B)
St. Petersburg, Société Electricité et Hydraulique 372
Société Ardoisière de l'Anjou, 1042
South Lancashire Tramways, 919..... (B)
Sunderland, 202..... (B)
Sydney (Australia), 502 ..... (B)
Trafford Park, 793
Tunbridge Wells, 912
Vienna, 905 ..... (B)
Warrington, 313 ..... (B)
West Bromwich, 305 ..... (ST)
Western Ohio Railway, 561
Westinghouse, 216
Whitehall Portland Cement Co., Cementon, Pa., 473
Worcester, 1036 ..... (B)
Yarmouth, 111 ..... (B)

WATER-DRIVEN.

Assabet Mills, Maynard Mass., 578
Blaenau-Festiniog, 203 ..... (B)
Bogota, 105
Burlington, Vermont, 723
Butte, Cal., 795
California and Virginia Mining Co., Nevada, 215
Cascade, 374
Cauveri Falls, 97
Champ, 302
Chêvres, 724
Concord, N.H., 98
Cuantillan, Mexico, 140
Evenstad Falls, 373 .....(6-phase)
Fumay Ardennes, 101
Fure et Morge, 428 (Société Hydro-Électrique de)
Goldstream-Victoria, Canada, 208
Hamilton, Canada, 104
Jungfrau Railway, 916
Lake Copais, 1037
Lausanne, 722, 726
Manchester Cotton Mills, N.H., 702
Manchester, N.H., 647
Mill Creek, Redlands, Cal., 703
Newfoundland, 910
Otanabee River, Canada, 499
Ottawa, 96 .....(steam auxiliary)
Pike's Peak, 99
Portland, Me, 559
Saint-Georges, 200
St. Maurice, 722, 724
Sault Ste. Marie, 303
Soulanges, 53
Springfield, Mass, 309
Swan Falls, Idaho, 429
The Dalles, 796
Valtelina Railway, 430, 942
Vancouver, 913
Volta, Cal., 705
Vouvry, 371, 724

GAS-ENGINE-DRIVEN.

Antwerp Steel Works (extensions), 312
Romanshorn, Switzerland, 106

Digitized by Google

The Gresham Press,
UNWIN BROTHERS, LIMITED,
WOKING AND LONDON.

Digitized by Google

Digitized by Google

Readers of "Science Abstracts" interested in

MECHANICAL ENGINEERING—CONSTRUCTIONAL ENGINEERING—METALLURGY—TRACTION—PRIME MOVERS—MUNICIPAL ENGINEERING—MARINE ENGINEERING AND SHIPBUILDING—ENGINEERING ECONOMICS,

will find original articles relating to these subjects appearing in the British, American, and European Press fully abstracted by specialists in

FEILDEN'S MAGAZINE.

On and after January, 1904, to be called

The Engineering Review.

THE "ABSTRACT" SECTION COMPRISES 32 PAGES EVERY MONTH.

Annual Subscription 12/6, Post Free to any Address.

Feilden's Magazine, 104, High Holborn, London, W.C.

PHILLIPS'

MONTHLY MACHINERY REGISTER,

TOGETHER WITH

Electrical and Autocar Supplement.

30th YEAR OF PUBLICATION.

The World's Best Medium for the Sale of New and Second-Hand Machinery of every Description: should be of practical value to all Works' Managers and Engineers, as many Bargains are met with.

SEND FOR SPECIMEN COPY AT ONCE.

Price 6d. Annual Subscription 6s., post paid to any address.

CHARLES D. PHILLIPS, NEWPORT MON.

NEW ALTERNATING METERS

Non-Inductive and Inductive Types.

WATT METERS. AMPERE HOUR METERS.
METERS FOR BATTERY WORK.
METERS FOR TRAMWAY CIRCUITS.

DOUBLE COIL WATT METER.

ELECTRICITY METERS.

CONTINUOUS AND ALTERNATING CIRCUITS.

Now Ready.

ACCURATE, LASTING, RELIABLE. PRICES MODERATE.

G. BRAULIK 217 & 218, Upper Thames St., **LONDON**

Telephone 307 Bank. Telegrams "BRAULIK, LONDON."

DARWIN BROTHERS, LIMITED, THE QUEENSLAND PRESS, WORTING AND LONDON.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google